TeSys® T LTM R Modbus® Motor Management Controller User's Manual

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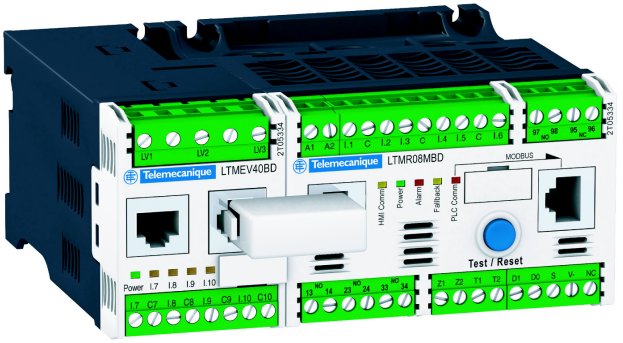

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1639501

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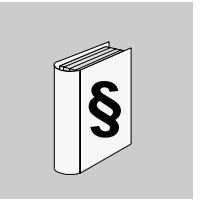
Safety Information



Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation, which, if not avoided, **will result** in death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

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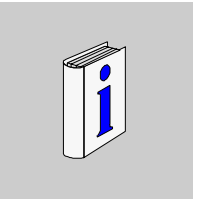
About the Book



At a Glance

Document Scope

This manual describes the Modbus® network protocol version of the TeSys® T LTM R motor management controller and LTM E expansion module. The purposes of this manual are twofold:

- to describe and explain the monitoring, protection, and control functions of the LTM R controller and expansion module
- to give you the information you need to implement and support a solution that best meets your application requirements

The manual describes the 4 key parts of a successful system implementation:

- installing the LTM R controller and expansion module
- commissioning the LTM R controller by setting essential parameter values
- using the LTM R controller and expansion module, both with and without additional human-machine interface devices
- maintaining the LTM R controller and expansion module

This manual is intended for:

- design engineers
- system integrators
- system operators
- maintenance engineers

Validity Note

The data and illustrations found in this book are not binding. We reserve the right to modify our products in line with our policy of continuous product development. The information in this document is subject to change without notice and should not be construed as a commitment by Schneider Electric.

Related Documents

Title of Documentation	Reference Number
TeSys® T LTM R CANopen Motor Management Controller User's Manual	1639503
TeSys® T LTM R DeviceNet™ Motor Management Controller User's Manual	1639504
TeSys® T LTM R Profibus Motor Management Controller User's Manual	1639502

You can download these technical publications and other technical information from our website at www.telemecanique.com.

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Schneider Electric assumes no responsibility for any errors that may appear in this document. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When controllers are used for applications with technical safety requirements, please follow the relevant instructions.

Failure to use Schneider Electric software or approved software with our hardware products may result in improper operating results.

Failure to observe this product related warning can result in injury or equipment damage.

User Comments

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Introducing the TeSys® T Motor Management System

1

At a Glance

Overview

This chapter introduces the TeSys® T Motor Management System and its companion devices.

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Presentation of the TeSys® T Motor Management System	16
System Selection Guide	24
Physical Description of the LTM R Motor Management Controller with Modbus® Protocol	31
Physical Description of the LTM E Expansion Module	35
Technical Specifications of the LTM R Controller	38
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Presentation of the TeSys® T Motor Management System

Aim of the Product

The TeSys® T Motor Management System offers protection, control, and monitoring capabilities for single-phase and 3-phase AC induction motors.

The system is flexible and modular and can be configured to meet the needs of applications in industry. The system is designed to meet the needs for integrated protections systems with open communications and global architecture.

More accurate sensors and solid-state full motor protection ensures better utilization of the motor. Complete monitoring functions enable analysis of motor operating conditions and faster reaction to prevent system downtime.

The system offers diagnostic and statistics functions and configurable warnings and faults, allowing better prediction of component maintenance, and provides data to continuously improve the entire system.

Examples of Supported Machine Segments

The motor management system supports the following machine segments:

Machine segment	Examples

Process and special machine segments	Water and waste water treatment
	• water treatment (blowers and agitators)
	
	Metal, Minerals and Mining
	• cement
	• glass
	• steel
	• ore extraction
	
	Oil and gas
	• oil and gas processing
	  • petrochemical
	  • refinery, offshore platform
	
	Microelectronic
	Pharmaceutical
	Chemical industry
	• cosmetics
	• detergents
	• fertilizers
	• paint
	
	Transportation industry
	• automotive transfer lines
	• airports
	
	Other industry
	• tunnel machines
	• cranes

Complex machine segments	Includes highly automated or coordinated machines used in: • pumping systems • paper conversion • printing lines • HVAC

Supported Industries

The motor management system supports the following industries and associated business sectors:

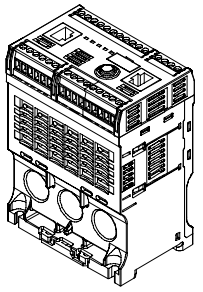
Industry	Sectors	Application
Building	• office buildings • shopping centers • industrial buildings • ships • hospitals • cultural facilities • airports	Control and manage the building facilities: • critical HVAC systems • water • air • gas • electricity • steam
Industry	• metal, mineral, and mining: cement, glass, steel, ore-extraction • microelectronic • petrochemical • ethanol • chemical: pulp and paper industry • pharmaceutical • food and beverage	• control and monitor pump motors • control ventilation • control load traction and movements • view status and communicate with machines • process and communicate the data captured • remotely manage data for one or several sites via Internet
Energy and Infrastructure	• water treatment and transportation • transportation infrastructure for people and freight: airports, road tunnels, subways and tramways • power generation and transport	• control and monitor pump motors • control ventilation • remotely control wind turbine • remotely manage data for one or several sites via the internet

TeSys® T Motor Management System

The two main hardware components of the system are the LTM R controller and the LTM E expansion module. The system can be configured and controlled using a Magelis® HMI device, a PC with PowerSuite™ software, or remotely over the network using a PLC. Components such as external motor load current transformers and ground current transformers add additional range to the system.

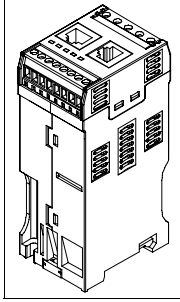
LTM R Controller

The range includes six LTM R controller models using Modbus® communication protocol. The microprocessor-based LTM R controller is the central component in the system that manages the control, protection and monitoring functions of single-phase and 3-phase AC induction motors. The LTM R controller is designed to work over various fieldbus protocols. This manual focuses only on systems designed to communicate over the Modbus protocol.

LTM R controller	Functional description	Reference number
	• current sensing 0.4...100 A • single-phase or 3-phase current inputs • 6 discrete logic inputs • 4 relay outputs: 3 SPST, 1 DPST • connections for a ground current sensor • connection for a motor temperature sensor • connection for network • connection for HMI device or expansion module • current protection, metering and monitoring functions • motor control functions • power indicator • fault and warning LED indicators • network communication and alarm indicators • HMI communication LED indicator • test and reset function	LTMR08MBD (24 Vdc, 0.4...8 A FLC) LTMR27MBD (24 Vdc, 1.35...27 A FLC) LTMR100MBD (24 Vdc, 5...100 A FLC) LTMR08MFM (100...240 Vac, 0.4...8 A FLC) LTMR27MFM (100...240 Vac, 1.35...27 A FLC) LTMR100MFM (100...240 Vac, 5...100 A FLC)

LTM E Expansion Module

The range includes two models of the expansion module that provide voltage monitoring functionality and 4 additional logic inputs. The expansion module is powered by the LTM R controller via a connector cable.

LTM E expansion module	Functional description	Reference number
	• Voltage sensing 110...690 Vac • 3 phase voltage inputs • 4 additional discrete logic inputs • additional voltage protection, metering and monitoring functions • power LED indicator • logic input status LED indicators Additional components required for an optional expansion module: • LTM R controller to LTM E connection cable	LTMEV40BD (24 Vdc) LTMEV40FM (100...240 Vac)

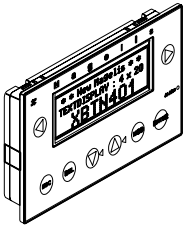
PowerSuite™ Software

PowerSuite software is a Microsoft® Windows®-based application that enables you to configure and commission the LTM R controller from a PC. You can also use PowerSuite software to modify default logic or create new logic using pre-made function blocks and elements.

PowerSuite software	Functional description	Reference number
	• commission the system through menu entries • configure the system through menu entries • display warnings and faults Additional components required for PowerSuite software: • a PC • separate power source • LTM R/LTM E to PC communication cable	LTM CONF VW3A8106 (PC communications cable)

Magelis® XBTN410 HMI

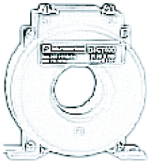
The system uses the Magelis® XBTN410 HMI (human-machine interface) device with a liquid crystal display and navigation buttons for metering, configuring and operating the LTM R controller. This HMI device is compact in size for door-mounted applications. It must be programmed using XBTL1000 programming software.

Magelis® XBT HMI	Functional description	Reference number
	• commission the system through menu entries • configure the system through menu entries • display warnings and faults Additional components required for an optional HMI device: • separate power source • LTM R/LTM E to HMI communication cable • Magelis XBTL1000 programming software	XBTN410 (HMI) XBTZ938 (cable) XBTL1000 (software)

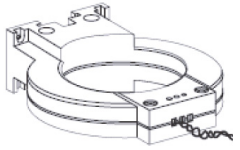
Current Transformers

External load current transformers expand the current range for use with motors greater than 100 full load Amperes. External ground current transformers measure ground fault conditions.

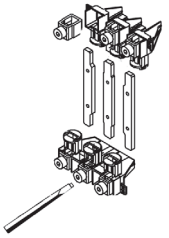
External current transformers expand the current range for use with motors greater than 100 full load Amperes.

Telemecanique® current transformers	Primary	Secondary	Inside diameter		Reference number
			mm	in	
	100	1	35	1.38	LT6CT1001
	200	1	35	1.38	LT6CT2001
	400	1	35	1.38	LT6CT4001
	800	1	35	1.38	LT6CT8001
	Note: The following current transformers are also available: Telemecanique® LUTC0301, LUTC0501, LUTC1001, LUTC2001, LUTC4001, and LUTC8001.				

External ground current transformers measure ground fault conditions.

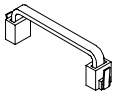
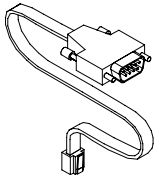
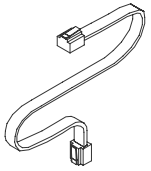
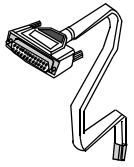
Merlin Gerin® Vigirex™ ground current transformers	Type	Maximum current	Inside diameter		Transformation ratio	Reference number
			mm	in		
	TA30	65 A	30	1.18	1000:1	50437
	PA50	85 A	50	1.97		50438
	IA80	160 A	80	3.15		50439
	MA120	250 A	120	4.72		50440
	SA200	400 A	200	7.87		50441
	PA300	630 A	300	11.81		50442

Lug-lug kit provides bus bars and lug terminals that adapt the pass through wiring windows and provide line and load terminations for the power circuit.

Square D Lug-lug Kit	Description	Reference number
	Square D Lug-lug Kit	MLPL9999

Cables

System components require cables to connect to other components and communicate with the network.

Cable	Description	Reference number
	LTM R to LTM E connector cable 40mm (1.57 in) length (closely couples the expansion module to the left side of the LTM R controller)	LTMCC004
	LTM R to LTM E RJ45 connector cable 0.3m (11.81 in) length	LU9R03
	LTM R to LTM E RJ45 connector cable 1.0m (3.28 ft) length	LU9R10
	PowerSuite™ cable kit, includes LTM E / LTM R to PC communication cable 1.0m (3.28 ft) length	VW3A8106
	Modbus® network communication cable 0.3m (11.81 in) length	VW3A8306R03
	Modbus network communication cable 1.0m (3.28 ft) length	VW3A8306R10
	Modbus network communication cable 3.0m (9.84 ft) length	VW3A8306R30
	LTM R / LTM E to Magelis® HMI device communication cable 2.5m (8.20 ft) length	XBTZ938

System Selection Guide

Overview

This section describes the LTM R controller with and without the optional expansion module for metering and monitoring, protection, and control functions

- **Metering and Monitoring functions**
  - measurements
  - statistics
  - system and device monitoring
  - motor states
  - fault and warning monitoring
- **Protection functions**
  - thermal motor protection
  - current motor protection
  - voltage and power motor protection
- **Control functions**
  - control modes (local/remote control source selection)
  - operating modes
  - fault management

Metering Functions

The following table lists the equipment required to support the metering functions of the motor management system:

Function	LTM R controller	LTM R controller with expansion module
Measurement		
Line currents	X	X
Ground current	X	X
Average current	X	X
Current phase imbalance	X	X
Thermal capacity level	X	X
Motor temperature sensor	X	X
Frequency	–	X
Line to line voltage	–	X
Line voltage imbalance	–	X
Active power	–	X
Reactive power	–	X
Power factor	–	X
Active power consumption	–	X
Reactive power consumption	–	X
Statistics		
Protection fault counts	X	X
Protection warning counts	X	X
Diagnostic fault counts	X	X
Motor control function counts	X	X
Fault history	X	X
System and Device Monitoring Faults		
Internal watchdog faults	X	X
Controller internal temperature	X	X
Temperature sensor connections	X	X
Current connections	X	X
Voltage connections	–	X
Control command diagnostics (start check, stop check, run check back, and stop check back)	X	X
X = the functionality is available with the units indicated **– = the functionality is not available with the units indicated**		

Function	LTM R controller	LTM R controller with expansion module
Control configuration checksum	X	X
Communication loss	X	X
Motor Statistics		
Motor starts / O1 starts / O2 starts	X	X
Operating time	X	X
Motor starts per hour	X	X
Last start max current	X	X
Last start time	X	X
Thermal Overload		
Time to trip	X	X
Time to reset	X	X
System Operating Statistics		
Motor running	X	X
On	X	X
Ready	X	X
Fault	X	X
Warning	X	X
Minimum wait time	X	X
X = the functionality is available with the units indicated **– = the functionality is not available with the units indicated**		

Fault and Warning Monitoring

The LTM R controller provides fault monitoring functions. When connected to an expansion module, the LTM R controller provides additional voltage fault monitoring.

Protection Category	Monitored Fault	LTM R controller	LTM R controller with expansion module
Diagnostic	Run command check	X	X
	Stop command check	X	X
	Run check back	X	X
	Stop check back	X	X
Wiring / configuration errors	PTC connection	X	X
	CT reversal	X	X
	Voltage phase reversal	–	X
	Current phase reversal	X	X
	Voltage phase loss	–	X
	Phase configuration	X	X
Internal	Stack overflow	X	X
	Watchdog	X	X
	ROM checksum	X	X
	EEROM	X	X
	CPU	X	X
	Internal temperature	X	X
Motor temp sensor	PTC binary	X	X
	PTC analog	X	X
	NTC analog	X	X
Thermal overload	Definite	X	X
	Inverse thermal	X	X
Current	Long start	X	X
	Jam	X	X
	Current phase imbalance	X	X
	Current phase loss	X	X
	Overcurrent	X	X
	Undercurrent	X	X
	Internal ground current	X	X
	External ground current	X	X

X = the functionality is available with the units indicated
– = the functionality is not available with the units indicated

Protection Category	Monitored Fault	LTM R controller	LTM R controller with expansion module
Voltage	Overvoltage	–	X
	Undervoltage	–	X
	Voltage phase imbalance	–	X
Power	Underpower	–	X
	Overpower	–	X
	Under power factor	–	X
	Over power factor	–	X
Communication loss	PLC to LTM R	X	X
	LTM E to LTM R	–	X
X = the functionality is available with the units indicated **– = the functionality is not available with the units indicated**			

Protection Functions

The following table lists the equipment required to support the protection functions of the motor management system:

Functions	LTM R controller	LTM R controller with expansion module
Thermal overload	X	X
Current phase imbalance	X	X
Current phase loss	X	X
Current phase reversal	X	X
Long start	X	X
Jam (locked rotor during run)	X	X
Undercurrent	X	X
Overcurrent	X	X
Ground current	X	X
Motor temperature sensor	X	X
Rapid cycle lockout	X	X
Voltage phase imbalance	–	X
Voltage phase loss	–	X
Voltage phase reversal	–	X
Undervoltage	–	X
Overvoltage	–	X
Load shedding	–	X
Underpower	–	X
Overpower	–	X
Under power factor	–	X
Over power factor	–	X
X = the functionality is available with the units indicated **– = the functionality is not available with the units indicated**		

Control Functions

The following table lists the equipment required to support the control functions of the motor management system:

Control functions	LTM R controller	LTM R controller with expansion module
Motor control modes		
Local terminal strip	X	X
Local HMI	X	X
Network	X	X
Operating mode		
Overload	X	X
Independent	X	X
Reverser	X	X
Two-step	X	X
Two-speed	X	X
Fault Management		
Manual reset	X	X
Automatic reset	X	X
Remote reset	X	X
X = the functionality is available with the units indicated **– = the functionality is not available with the units indicated**		

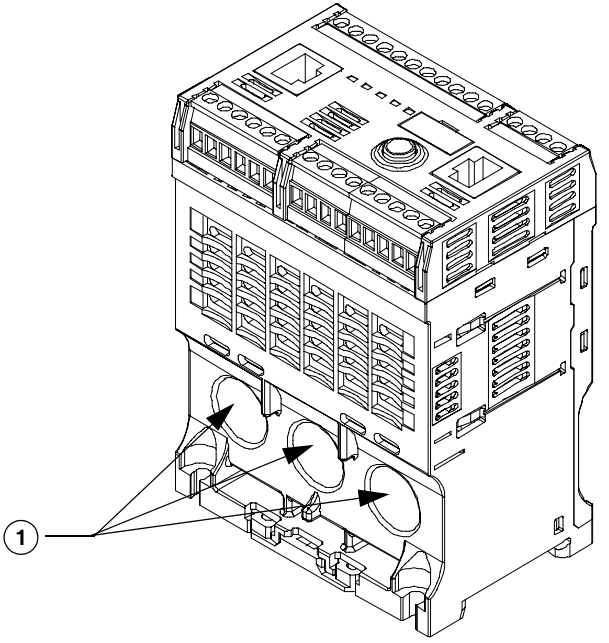
Physical Description of the LTM R Motor Management Controller with Modbus® Protocol

Overview

The microprocessor-based LTM R controller provides control, protection and monitoring for single-phase and 3-phase AC induction motors.

Phase Current Inputs

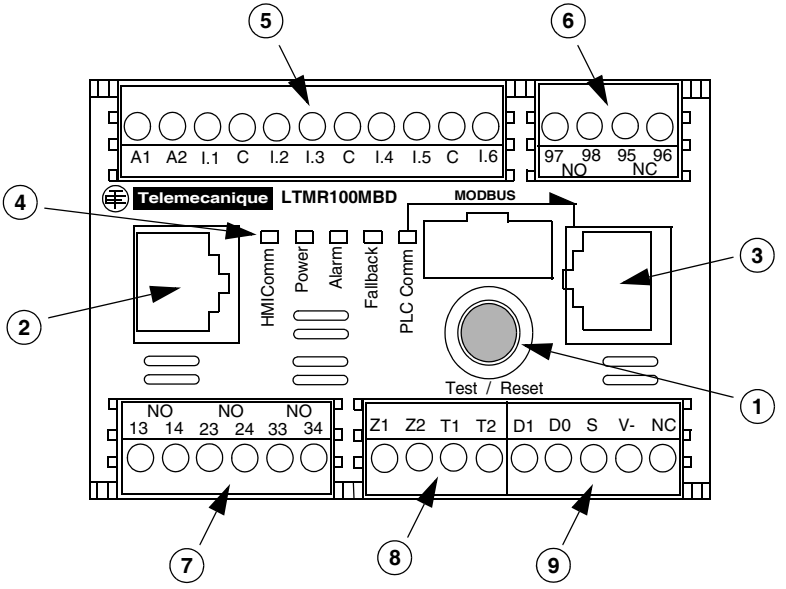
The LTM R controller includes internal current transformers for measuring the motor load phase current directly from the motor load power cables or from secondaries of external current transformers.



1 Windows for phase current measurement

Features of the Front Face

The LTM R controller front face includes the following features:



1 Test/Reset button
2 HMI port with RJ45 connector connecting the LTM R controller to an HMI, PC or expansion module
3 Network port with RJ45 connector connecting the LTM R controller to a Modbus PLC
4 Status-indicating LEDs
5 Plug-in terminal: control power, and internally powerd logic inputs and commons
6 Plug-in terminal: double pole/single throw (DPST) output relay
7 Plug-in terminal output relay
8 Plug-in terminal: ground fault input and temperature sensor input
9 Plug-in terminal: PLC network

Test/Reset Button

The Test/Reset button performs a reset, a self test, or places the LTM R controller in an internal fault state. For a detailed description of the test/rest button functions, see *p. 342*.

HMI Device/ Expansion Module/PC Port

This port connects the LTM R controller to the following devices over the HMI port using an RJ45 connector:

- an expansion module
- a PC running PowerSuite™ software
- a Magelis® XBTN410

Network Port

This port provides communication between the LTM R controller and a network PLC via an RJ45 connector.

LEDs

LTM R controller LED descriptions:

LED name	Describes	Appearance	Status
HMI Comm	Communication between LTM R controller and HMI device, PC, or expansion module	flashing yellow	communication
		off	no communication
Power	LTM R controller power or internal fault condition	solid green	power on, motor off, no internal faults
		flashing green	power on, motor on, no internal faults
		off	power off or internal faults exist
Alarm	Protection warning or fault, or internal fault	solid red	internal or protection fault
		flashing red (2 flashes / s)	warning
		flashing red (5 flashes / s)	load shed or rapid cycle
		off	no faults, warnings, load shed or rapid cycle (when power is on)
Fallback	Indicates communications loss between the LTM R controller and network or HMI control source	solid red	fallback
		off	no power (not in fallback)
PLC Comm	indicates network activity	flashing yellow (0.2 s on,1.0 s off	communication on the network bus
		off	no network bus communication

Plug-in Terminals and Pin Assignments

The LTM R controller has the following plug-in terminals and pin assignments:

Terminal block	Pin	Description
Control Voltage, Logic Input, and Common Source Terminals For information on logic input behavior, see *p. 226*.	A1	supply voltage input (+ / ~)
	A2	the negative of a power supply for DC models, or the grounded secondary of a control power transformer for AC models (– / ~)
	I1	Logic Input 1
	I2	Logic Input 2
	I3	Logic Input 3
	I4	Logic Input 4
	I5	Logic Input 5
	I6	Logic Input 6
	C	Input common

Terminal block	Pin	Description
DPST Relay Output Terminals For information on logic output behavior, see *p. 227*.	97–98	NC contact
	95–96	NO contact
	Note: The 97–98 contacts and the 95–96 contacts are on the same relay, so the open/closed status of one pair of contacts is always the opposite of the status of the other pair.	
Relay Output Terminals	13–14	NO contact – logic output 1
	23–24	NO contact – logic output 2
	33–34	NO contact – logic output 3
Ground Fault Input, Temperature Sensor Input, and PLC Terminals	Z1–Z2	connection for external ground fault current transformer
	T1–T2	connection for motor temperature sensors
	D0 or D(A)	generator terminal 0, Va voltage
	D1 or D(B)	generator terminal 1, Vb voltage
	S	Modbus® shield pin
	V-	Modbus common pin
	NC	Modbus VP pin (not connected)

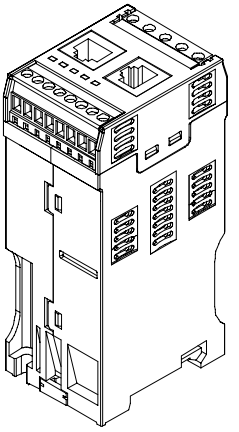
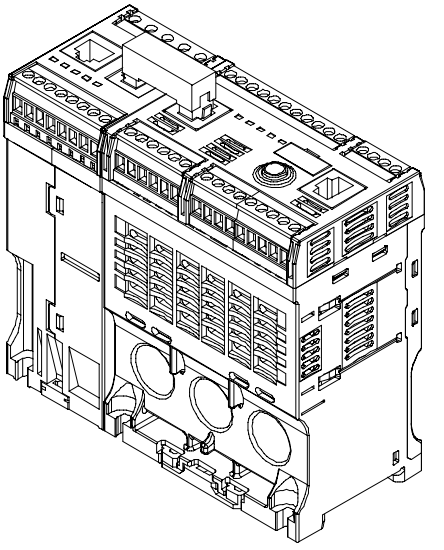
Physical Description of the LTM E Expansion Module

Overview

The expansion module extends the functionality of the LTM R controller by providing voltage monitoring and additional input terminals:

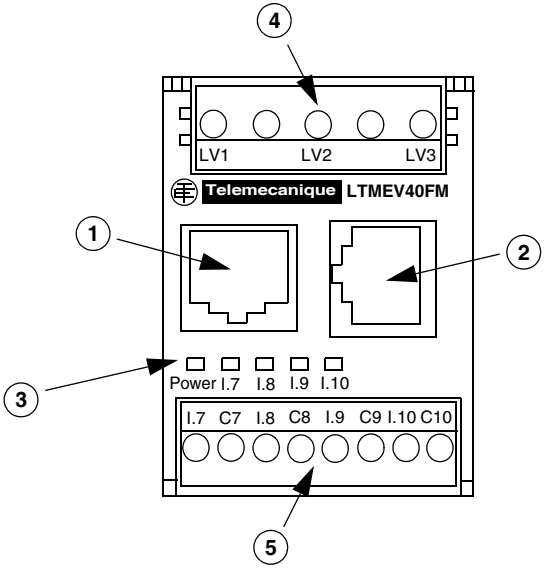
- 3 phase voltage inputs
- 4 additional discrete logic inputs

Note: Logic inputs are externally powered according to input voltage ratings.

Expansion module	Expansion module connected to an LTM R controller
	

Expansion Module Front Face

The expansion module front face includes the following features:.



1 Port with RJ45 connector to HMI or PC
2 Port with RJ45 connector to LTM R controller
3 Status-indicating LEDs
4 Plug-in terminal: voltage inputs
5 Plug-in terminal: logic inputs and common

HMI/PC Port

This port, with an RJ45 connector, connects the expansion module to the following devices:

- a PC running PowerSuite™ software
- a Magelis® XBTN410

LTM R Controller Port

This port connects the expansion module to the LTM R controller using an RJ45 connector.

LEDs

The expansion module LEDs indicate the following behaviors:

LED name	Description	Appearance	Status
Power	Power/Fault status	green	power on, no faults
		red	power on, faults
		off	not powered
I.7	Logic Input I.7 status	yellow	activated
		off	not activated
I.8	Logic Input I.8 status	yellow	activated
		off	not activated
I.9	Logic Input I.9 status	yellow	activated
		off	not activated
I.10	Logic Input I.10 status	yellow	activated
		off	not activated

Plug-in Terminals and Pin Assignments

The expansion module has the following plug-in terminals and pin assignments:

Terminal block	Pin	Description
Voltage Inputs	LV1	phase 1 input voltage
	LV2	phase 2 input voltage
	LV3	phase 3 input voltage
Logic Inputs and Common Terminals	I.7	logic Input 7
	C7	common for I.7
	I.8	logic Input I.8
	C8	common for I.8
	I.9	logic Input I.9
	C9	common for I.9
	I.10	logic Input I.10
	C10	common for I.10

Technical Specifications of the LTM R Controller

Technical Specifications

The LTM R controller meets the following specifications:

Certification[1]	UL, CSA, CE, CTIC'K, CCC, NOM, GOST, IACS E10 (BV, LROS, DNV, GL, RINA, ABS, RMRos), ATEX		
Conformity to Standards	IEC/EN 60947-4-1, UL 508, CSA C22.2 no.14, IACS E10		
European community directives	CE marking, satisfies the essential requirements of the low voltage (LV) machinery and electromagnetic compatibility (EMC) directives.		
Rated insulation voltage (Ui)	According to IEC/EN 60947-1	overvoltage category III, degree of pollution: 3	690 V
	According to UL508, CSA C22-2 no. 14		690 V
Rated impulse withstand voltage (Uimp)	According to IEC60947-1 8.3.3.4.1 paragraph 2	220 V power, input and output circuits	4.8 kV
		24 V power, input and output circuits	0.91 kV
		communication circuits	0.91 kV
		PTC and GF circuits	0.91 kV
Degree of protection	According to 60947-1 (protection against direct contact)		IP20
Protective treatment	IEC/EN 60068		"TH"
	IEC/EN 60068-2-30	Cycle humidity	12 cycles
	IEC/EN 60068-2-11	Salt spray	48 hr
Ambient air temperature around the device	Storage		-40…+80 °C (-40…176 °F)
	Operation		-20…+60 °C (-4…140 °F)
Maximum operating altitude	Derating accepted		4500 m (14763 ft)
	without derating		(2000 m (6561 ft)
Fire resistance	According to UL 94		V2
	According to IEC 695-2-1	(Parts supporting live components)	960 °C (1760 °F)
		(other components)	650 °C (1202 °F)

1. **Some certifications are in progress.**
2. **Without modifying the state of the contacts in the least favorable direction.**
3. **NOTICE: This product has been designed for use in environment A. Use of this product in environment B may cause unwanted electromagnetic disturbance, which may require the implementation of adequate mitigation measures.**

Half-sine mechanical shock pulse = 11 ms	According to CEI 60068-2-27[2]		15 gn
Resistance to vibration	According to CEI 60068-2-6[2]	Panel mounted	4 gn
		DIN rail mounted	1 gn
Immunity to electrostatic discharge	According to EN61000-4-2	Through air	8 kV level 3
		Over surface	6 kV level 3
Immunity to radiated fields	According toEN61000-4-3		10 V/m level 3
Immunity to fast transient bursts	According to EN61000-4-4	On power lines and relay outputs	4 kV level 4
		all other circuits	2 kV level 3
Immunity to radioelectric fields	According to EN61000-4-6[3]		10 V rms level 3
Surge immunity	According to IEC/EN 61000-4-5	Common mode	Differential mode
	Power lines and relay outputs	4 kV (12 Ω/9 F)	2 kV (2 Ω/18 F)
	24 Vdc inputs and power	1 kV (12 Ω/9 F)	0.5 kV (2 Ω/18 F)
	100-240 Vac inputs and power	2 kV (12 Ω/9 F)	1 kV (2 Ω/18 F)
	Communication	2 kV (12 Ω/18 F)	–
	Temperature sensor (IT1/IT2)	1 kV (42 Ω/0.5 F)	0.5 kV (42 Ω/0.5 F)

1. **Some certifications are in progress.**
2. **Without modifying the state of the contacts in the least favorable direction.**
3. **NOTICE: This product has been designed for use in environment A. Use of this product in environment B may cause unwanted electromagnetic disturbance, which may require the implementation of adequate mitigation measures.**

Control Voltage Characteristics

The LTM R controller has the following control voltage characteristics:

Control Voltage		**24 Vdc**	**100-240 Vac**
Power consumption	According to IEC/EN 60947-1	56...127 mA	8...62.8 mA
Control voltage range	According to IEC/EN 60947-1	20.4...26.4 Vdc	93.5...264 Vac
Overcurrent protection		24 V fuse 0.5 A gG	100-240 V fuse 0.5 A gG
Resistance to Microbreaks		3 ms	3 ms
Resistance to voltage dips	According to IEC/EN 61000-4-11	70% of UC min. for 500 ms	70% of UC min. for 500 ms

Logic Inputs Characteristics

The LTM R controller logic inputs, I.1 to I.6, are internally powered by the control voltage of the LTM R controller. LTM R controller inputs are isolated from the inputs of the expansion module. LTM R controller logic inputs have the following characteristics:

Nominal input values		Voltage	24 Vdc	100-240 Vac
		Current	7 mA	• 3.1 mA at 100Vac • 7.5 mA at 240 Vac
Input limit values	At state 1	Voltage	15 V maximum	79 V < V < 264 V
		Current	2 mA min to 15 mA max.	2 mA min. at 110 Vac to 3 mA min. at 220 Vac
	At state 0	Voltage	5 V maximum	0V < V < 40 V
		Current	15 mA maximum	15 mA maximum
Response time	Change to state 1		15 ms	25 ms
	Change to state 0		5 ms	25 ms
IEC 1131-1 conformity			Type 1	Type 1
Type of Input			Resistive	Capacitive

Logic Outputs Characteristics

The controller logic outputs, O.1 to O.4, are internally powered by the control voltage of the controller. Controller logic outputs have the following characteristics:

Rated insulation voltage	300 V
AC rated thermal load	250 Vac / 5 A
DC rated thermal load	30 Vdc / 5 A
AC 15 rating	480 VA, 500000 operations, Ie max = 2 A
DC 13 rating	30 W, 500000 operations, Ie max = 1.25 A
Associated fuse protection	gG at 4 A
Maximum operating rate	1800 cycles / hr
Maximum frequency	2 Hz (2 cycles / s)
Response time closing	< 10 ms
Response time opening	< 10 ms
Contact rating	B300

Altitude Derating The following table provides the deratings to apply for dielectric strengths and maximum operating temperature according to altitude.

Corrective factors for altitude	**2000 m (6561.68 ft)**	**3000 m (9842.52 ft)**	**3500 m (11482.94 ft)**	**4000 m (13123.36 ft)**	**4500 m (14763.78 ft)**
Dielectric Strength Ui	1	0.93	0.87	0.8	0.7
Max. Operating Temperature	1	0.93	0.92	0.9	0.88

Technical Specifications of the Expansion Module

Technical Specifications

The expansion module meets the following specifications:

Certifications[1]	UL, CSA, CE, CTIC'K, CCC, NOM, GOST, IACS E10 (BV, LROS, DNV, GL, RINA, ABS, RMRos), ATEX		
Conformity to Standards	IEC/EN 60947-4-1, UL 508 - CSA C22-2, IACSE10		
European community directives	CE marking. Satisfies the essential requirements of the low voltage (LV) machinery and electromagnetic compatibility (EMC) directives.		
Rated insulation voltage (Ui)	According to IEC/EN 60947-1	overvoltage category III, degree of pollution: 3	690 V UI on voltage inputs
	According to UL508, CSA C22-2 no. 14		690 V UI on voltage inputs
Rated impulse withstand voltage (Uimp)	According to IEC60947-1 8.3.3.4.1 Paragraph 2	220 V inputs circuits	4.8 kV
		24 V inputs circuits	0.91 kV
		communication circuits	0.91 kV
		voltage input circuits	7.3 kV
Degree of protection	According to 60947-1 (protection against direct contact)		IP20
Protective treatment	IEC/EN 60068		"TH"
	IEC/EN 60068-2-30	Cycle Humidity	12 Cycles
	IEC/EN 60068-2-11	Salt spray	48 hr
Ambient air temperature around the device	Storage		-40…+80 °C (-40…176 °F)
	Operation[2]	>40 mm (1.57 inches) spacing	-20…+60 °C (-4…140 °F)
		<40mm (1.57 inches) but >9 mm (0.35 inches) spacing	-20…+55 °C (-4…131 °F)
		<9 mm (0.35 inches) spacing	-20…+45 °C (-4…113 °F)
Maximum operating altitude	derating are accepted		4500 m (14763 ft)
	without derating		2000 m (6561 ft)

1. **Some certifications are in progress.**
2. **The maximum rated ambient temperature of the expansion module depends on the installation spacing with the LTM R controller.**
3. **Without modifying the state of the contacts in the least favorable direction.**
4. **NOTICE: This product has been designed for use in environment A. Use of this product in environment B may cause unwanted electromagnetic disturbance, which may require the implementation of adequate mitigation measures.**

Fire resistance	According to UL 94		V2
	According to IEC 695-2-1	(Parts supporting live components)	960 °C (1760 °F)
		(other components)	650 °C (1202 °F)
Half-sine mechanical shock pulse = 11 ms	According to CEI 60068-2-27[3]		30 g 3 axis and 6 directions
Resistance to vibration	According to CEI 60068-2-6[3]		5 gn
Immunity to electrostatic discharge	According to EN61000-4-2	Through air	8 kV Level 3
		Over surface	6 kV Level 3
Immunity to radiated fields	According toEN61000-4-3		10V/m Level 3
Immunity to fast transient bursts	According to EN61000-4-4	All circuits	4 kV Level 4 2 kV on all other circuits
Immunity to radioelectric fields	According to EN61000-4-6[4]		10 V rms Level 3
Surge Immunity	According to IEC/EN 61000-4-5	Common mode	Differential mode
	100-240 Vac inputs	4 kV (12 Ω)	2 kV (2 Ω)
	24 V dc inputs	1 kV (12 Ω)	0.5 kV (2 Ω)
	Communication	1 kV (12 Ω)	–

1. **Some certifications are in progress.**
2. **The maximum rated ambient temperature of the expansion module depends on the installation spacing with the LTM R controller.**
3. **Without modifying the state of the contacts in the least favorable direction.**
4. **NOTICE: This product has been designed for use in environment A. Use of this product in environment B may cause unwanted electromagnetic disturbance, which may require the implementation of adequate mitigation measures.**

Logic Inputs Characteristics

The expansion module logic inputs, I.7 to I.10, are externally powered. They are isolated from the LTM R controller's six inputs and are not powered by the control voltage of the LTM R controller. The expansion module logic inputs have the following characteristics:

Control voltage			**24 Vdc**	**115-230 Vac**
Nominal input values		Voltage	24 Vdc	100-240 Vac
		Current	7 mA	• 3.1 mA at 100Vac • 7.5 mA at 240 Vac
Input limit values	At state 1	Voltage	15 V maximum	79 V < V < 264 V
		Current	2 mA min to 15 mA max.	2 mA min. at 110 Vac to 3 mA min. at 220 Vac
	At state 0	Voltage	5 V maximum	0V < V < 40 V
		Current	15 mA maximum	15 mA maximum
Response time	Change to state 1		15 ms (input only)	25 ms (input only)
	Change to state 0		5 ms (input only)	25 ms (input only)
IEC 1131-1 conformity			Type 1	Type 1
Type of Input			Resistive	Capacitive

Altitude Derating

The following table provides the deratings to apply for dielectric strengths and maximum operating temperature according to altitude.

Corrective factors for altitude	**2000 m (6561.68 ft)**	**3000 m (9842.52 ft)**	**3500 m (11482.94 ft)**	**4000 m (13123.36 ft)**	**4500 m (14763.78 ft)**
Dielectric Strength Ui	1	0.93	0.87	0.8	0.7
Max. Operating Temperature	1	0.93	0.92	0.9	0.88

Configurable Parameters

General Parameter Settings

General configurable parameters for the LTM R controller and the expansion module are described below.

Note: The order of parameter configuration depends on the parameter configuration tool utilized. For information on the sequence of parameter configuration, refer to instructions on using the following parameter configuration tools:

- a Magelis® XBT HMI in a 1-to-1 configuration, see *p. 362*
- a Magelis XBT HMI in a 1-to-many configuration, see *p. 391*
- PowerSuite™ software, see *p. 436*
- the PLC *Configuration Variables, p. 483*

General configurable parameters for the LTM R controller and the expansion module include:

Parameter	Setting Range	Factory Default
Date and time	Year • 2006…2099	2006
	Month • January • February • March • April • May • June • July • August • September • October • November • December	January
	Day • 1…31	1
	Hour • 00…23	00
	Minute • 00…59	00
	Second • 00…59	00
Contactor rating	1…10000 A	810 A

Parameter	Setting Range	Factory Default
Control local channel setting	• Terminal strip • HMI	Terminal strip
Config via HMI keypad enable	• Enable • Disable	Enable
Config via HMI engineering tool enable	• Enable • Disable	Enable
Config via HMI network port enable	• Enable • Disable	Enable
Language	• English • Français • Español • Deutsch • Italiano	English
Motor auxiliary fan cooled	• Yes • No	No
Fault reset mode	• Manual • Remote • Automatic	Manual
Bumpless transfer mode	• Bump • Bumpless	Bump

Diagnostic Parameter Settings

Diagnostic configurable parameters for the LTM R controller and the expansion module include checks of start and stop commands and wiring:

Parameter	Setting Range	Factory Default
Diagnostic fault enable (see *p. 99*)	• Yes • No	No
Diagnostic warning enable	• Yes • No	No
Wiring fault enable (see *p. 102*)	• Yes • No	No

Fault Auto-Reset Parameter Settings

Fault auto-reset configurable parameters for the LTM R controller and the expansion module include:

Parameter	Setting Range	Factory Default
Auto-reset attempts group 1 setting	0=manual, 1, 2, 3, 4, 5=unlimited number of reset attempts	5
Auto-reset group 1 timeout	0...65535 s	480 s
Auto-reset attempts group 2 setting	0=manual, 1, 2, 3, 4, 5=unlimited number of reset attempts	0
Auto-reset group 2 timeout	0...65535 s	1200 s
Auto-reset attempts group 3 setting	0=manual, 1, 2, 3, 4, 5=unlimited number of reset attempts	0
Auto-reset group 3 timeout	0...65535 s	60 s

Load Current Transformer Parameter Settings

Load current transformer configurable parameters for the LTM R controller and the expansion module include:

Parameter	Setting Range	Factory Default
Load CT multiple passes	1...100	1
Load CT primary	1...65535	1
Load CT secondary	1...500	1
Load CT ratio	• None • 10:1 • 15:1 • 30:1 • 50:1 • 100:1 • 200:1 • 400:1 • 800:1 • Other Ratio	No Default

Ground Current Transformer Parameter Settings

Ground current transformer configurable parameters for the LTM R controller and the expansion module include:

Parameter	Setting Range	Factory Default
Ground current mode	• Internal • External	Internal
Ground current ratio	• None • 100:1 • 200:1.5 • 1000:1 • 2000:1 • Other Ratio	No Default
Ground CT primary	1…65535	1
Ground CT secondary	1…65535	1

Motor Parameter Settings

Motor configurable parameters for the LTM R controller and the expansion module include:

Parameter	Setting Range	Factory Default
Motor operating mode	• Overload - 2-wire • Overload - 3-wire • Independent - 2-wire • Independent - 3-wire • Reverser - 2-wire • Reverser - 3-wire • Two-Step - 2-wire • Two-Step - 3-wire • Two-Speed - 2-wire • Two-Speed - 3-wire • Custom	Independent 3-wire
Control direct transition	• On • Off	Off
Motor transition timeout	0...999.9 s	0.1 s
Motor step 1 to 2 timeout	0...999.9 s	5 s
Motor step 1 to 2 threshold	20...800% FLC in 1% increments	150%
Motor nominal power	0.1…999.9 kW in increments of 0.1 kW	7.5kW
Motor nominal voltage	110…690 V	400 V
Motor phases	• 3-phase motor • 1-phase motor	3-phase motor

Parameter	Setting Range	Factory Default
Motor phases sequence	• A-B-C • A-C-B	A-B-C
Motor auxiliary fan cooled	• Yes • No	No
Motor temp sensor type	• None • PTC Binary • PTC Analog • NTC Analog	None

Network Port Parameter Settings

The LTM R controller uses the network port to communicate with the Modbus master network controller. This port's configurable parameters include:

Parameter	Setting Range	Factory Default
Network port address	0...247	1
Network port baud rate	• 19200 • 9600 • 4800 • 1200	19200
Network port parity setting	• Even • None	Even
Config via network port enable	• Enable • Disable	Enable
Network port fallback setting	• Hold • Run • LO1, LO2 off • LO1, LO2 on • LO1 off • LO2 off	LO1, LO2 off
Network port fault enable	Enable/Disable	Enable
Network port comm loss timeout	0…9999 s	60 s
Network port warning enable	Enable/Disable	Enable

HMI Port Parameter Settings

HMI port configurable parameters for the LTM R controller and the expansion module:

Parameter	Setting Range	Factory Default
HMI port address setting	0...247	1
HMI port baud rate setting	• 19200 • 9600 • 4800 • 1200	19200
HMI port parity setting	• Even • None	Even
Config via HMI engineering tool enable	• Enable • Disable	Enable
Config via HMI keypad enable	• Enable • Disable	Enable
Network port fallback setting (used as HMI port fallback setting)	• Hold • Run • LO1, LO2 off • LO1, LO2 on • LO1 off • LO2 off	LO1, LO2 off
HMI port fault enable	Enable/Disable	Enable
HMI port fault time	7 s (fixed)	7 s
HMI port warning enable	Enable/Disable	Enable

Protection Parameter Settings

For a list of configurable protection parameters for the LTM R controller and expansion module, see *p. 119*.

Application Example

2

At a Glance

Overview

This chapter contains an example of how to configure the LTM R controller to start and protect a pump.

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Purpose	52
LTM R Controller Wiring	54
Configuring Parameters	55

Purpose

Overview

The following application example uses the LTM R controller to protect and control a motor and its driven load, in this example, a pump.

This application example is intended to:

- show you how to configure the LTM R controller in a few steps
- provide an example you can modify to develop your own configuration
- serve as a starting point for the development of more complex configurations, incorporating such additional features as HMI or network control.

Basic LTM R Controller Configuration

Configuring the LTM R controller includes 2 important steps:

- proper external wiring to support the monitoring, protection and control of the motor and LTM R controller
- configuring parameters that set the LTM R controller's monitoring, protection, and control functions using a configuration tool - in this example, PowerSuite™ software.

Operating conditions

- motor power: 4 kW
- line-to-line voltage: 400Vac
- current: 9 A
- control circuit voltage: 230 Vac
- 3-wire control
- motor trip class 10
- start button
- stop button
- reset button on enclosure door–customer provided
- fault light–customer provided
- warning light–customer provided
- full voltage, non-reversing starter (direct over the line starter)
- 24 Vdc power supply in the motor control center or control station for future use with expansion module inputs

Components Used

The application example includes the following components:

Item	Component description	Reference number
1	LTM R 100-240Vac Modbus® Motor Management Controller (1.35...27 A FLC)	LTMR27MFM
2	LTM E 24VDC Expansion Module	LTMEV40BD
3	LTM R to LTM E RJ45 connection cable	LU9R10
4	PowerSuite cable kit	VW3A8106
5	PowerSuite software on CD-ROM with LTM R upgrade	LTM CONF
6	External ground fault CT	TA30
7	External PTC binary motor temperature sensor	User supplied

Functions Performed

- Motor status is indicated.
- Motor state (On, Off, Warning, Fault) is indicated by LTM R controller LEDs.
- Thermal overload protection is provided.
- Motor temp sensor protection is provided.
- Voltage protection is required because undervoltage conditions are known to cause motor winding damage.
- External ground fault protection is provided.
- Initial system configuration is performed during commissioning using PC and PowerSuite software. External HMI device or PLC not required. However, an HMI is optional for later use to fine-tune parameter settings after an initial period of operation.

Prerequisites

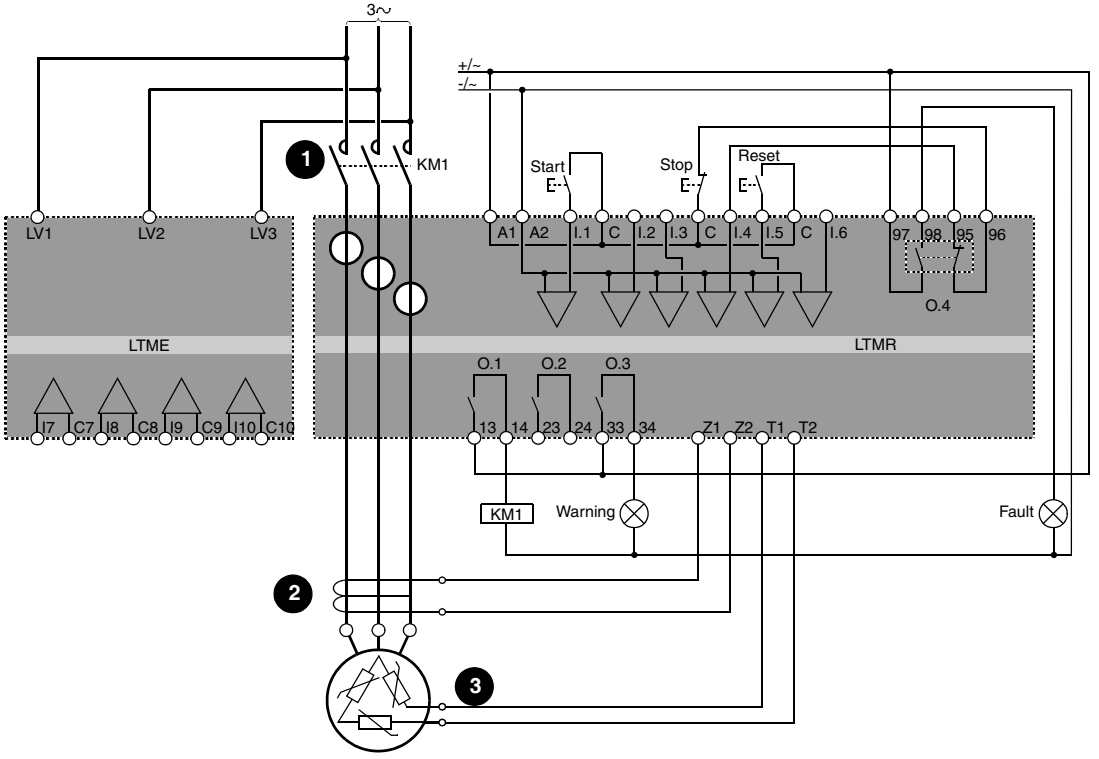
This application example assumes that the application designer has selected and properly installed the required hardware, and that the application has been commissioned by setting all minimally required configuration parameters. This example further assumes:

- The motor is present.
- The LTM R controller parameters are set to their factory default settings.
- PC running PowerSuite software is connected to the LTM R controller using a VW3A8106 PowerSuite cable.

LTM R Controller Wiring

Wiring Diagram

The following schematic depicts both the main power circuit and the 3-wire (impulse) control circuit:



1 contactor
2 ground fault current transformer
3 PTC binary thermistor

The wiring diagram, above, implements the control strategy inherent in the independent 3-wire predefined operating mode:

- Logic input I.1 activates a start command and latches logic output O.1.
- Logic input I.4 is the Stop command. A fault response:
  - trips logic output O.4, and
  - interrupts logic input I.4, thereby disabling the latch, and
  - opens logic output I.1

This wiring diagram is intended for use with the example application. For additional IEC format wiring diagrams, see *p. 511*. For NEMA format wiring diagrams, see *p. 531*.

Configuring Parameters

Overview

After the wiring connections are made, the next step is to configure parameters. There are two steps to successful parameter configuration:

1 Enter the operating and protection parameter settings using PowerSuite™ software running in your PC.

2 Transfer the previously saved configuration file with all parameter settings from your PC to the LTM R controller.

Because this application example accepts the default factory settings of most parameters, only a few parameters need to be configured.

Required Parameters

The following operating and protection parameters must be configured:

Operating parameters:

Parameter	Setting
Motor nominal voltage	400 Vac
Motor full load current	9 A
Motor phases	3-phase motor
Motor operating mode	Independent - 3-wire (impulse)
Motor temp sensor type	PTC Binary
Control local channel setting	Terminal strip
Load CT primary	1
Load CT secondary	1
Load CT multiple passes	1
Ground CT primary	1000
Ground CT secondary	1

Protection parameters:

Parameter	Parameter setting
Thermal overload mode	Inverse thermal
Thermal overload fault enable	Enable
Thermal overload warning enable	Enable
Motor Trip Class	10
Ground current mode	External
Ground current fault enable	Enable
Ground current fault timeout	0.5 s
Ground current fault threshold	2 A

Parameter	Parameter setting
Ground current warning enable	Enable
Ground current warning threshold	1 A
Undervoltage fault enable	Enable
Undervoltage fault threshold	85% of Vnom
Undervoltage fault timeout	3 s
Undervoltage warning enable	Enable
Undervoltage warning threshold	90% of Vnom

Enter Parameter Settings

Use the PowerSuite™ software to:

- open a configuration file with factory default settings
- edit the settings of the required parameters listed above
- save a copy of the completed configuration settings to a new configuration file

Saving a copy of your configuration settings provides you with a record of your configuration, and helps you identify your configuration settings in case you ever need to re-download them to the LTM R controller.

To create a configuration file, follow these steps:

Step	Description
1	Start up the PowerSuite software.
2	In the Load Configuration screen, select **Default** and click **Ok**. This loads the default factory settings into your configuration software.
3	Open the Settings branch of the tree control.
4	In the Motor sub-branch, locate and set the Operating parameter settings.
5	In the Current sub-branch, locate and set the Protection parameter settings.
6	In the File menu, select **Save as**. The Save As window opens.
7	In the Save As window: • type in a new file name • accept the default file location ("Configurations") or navigate to a new location • click **Save**.

Your configuration settings have been made and saved with a new filename on your PC. Next, you must transfer this configuration file to the LTM R controller.

Transfer Configuration File

Transferring your configuration to the LTM R controller is a 2-step process:

- connect your PC to the LTM R controller
- transfer the configuration file.

To do this:

Step	Description
1	Be sure your configurations are displayed in the PowerSuite software.
2	Check the task bar to see whether your PC is connected to the LTM R controller.
3	If the task bar reads "Disconnected", select **Connect** in either the Link menu or the icon bar. A progress bar briefly appears as your PC connects to the LTM R controller, and the word Connected appears in the task bar when the connection process successfully completes.
4	Select **PC to Device**, in either the Link → File Transfer sub-menu or the icon bar. The Upload Configuration dialog opens, asking if you want to continue.
5	In the Upload Configuration dialog, click **Continue**. A progress bar briefly appears.
6	To confirm that the transfer succeeded, check the results in the Output window, which opens automatically at the bottom of the Main window.

Metering and Monitoring Functions

3

At a Glance

Overview

The LTM R controller provides current sensing, metering, and monitoring in support of the current, temperature and ground fault protection functions. When connected to an expansion module, the LTM R controller also provides voltage and power sensing functions. Metering and monitoring can be categorized as follows:

- Measurements: real-time or calculated measurements of current, voltage, or power provided by analog inputs
- Statistics: protection, diagnostic, motor control, and historical fault and warning counts stored by the LTM R controller, for analysis of system performance and maintenance
- System and device faults: faults affecting the LTM R controller's ability to operate properly, (internal check, communications, wiring, and configuration errors)
- Motor statistics: historical data describing motor starts and operating time, for analysis of device operation
- Thermal overload display data: displaying estimates of the time until the next thermal overload fault and, after a thermal overload fault has occurred, the time to reset
- System operating status: including the motor state (on, ready, run, fault, warning) and the time for auto-reset of faults.

What's in this Chapter?

This chapter contains the following sections:

Section	Topic	Page
3.1	Summary of Characteristics	61
3.2	Measurements	68
3.3	Fault and Warning Counters	88
3.4	System and Device Monitoring Faults	95
3.5	Motor History	108
3.6	Thermal Overload Statistics	112
3.7	System Operating Status	113

3.1 Summary of Characteristics

Overview

Introduction

This section provides a summary of characteristics for the measurement, statistics, diagnostic fault, motor statistics, thermal overload and system operating functions available using the LTM R controller and the expansion module.

What's in this Section?

This section contains the following topics:

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Accessing Metering Functions and Parameter Data	62
Measurements	63
Fault and Warning Counters	64
System and Device Monitoring Faults	65
Motor History	66
Thermal Overload Statistics	67
System Operating Status	67

Accessing Metering Functions and Parameter Data

HMI Tools

Use any of the following user interface tools to monitor the metering functions and parameters included in a pre-defined operating mode:

- a PC with PowerSuite™ software
- the Magelis® XBTN410 HMI device
- a PLC via the remote communication link.

For more information about pre-defined operating modes, see *p. 222*.

Customized Functions and Data

In addition to monitoring metering functions and parameters incorporated in a pre-defined operating mode, you can use the Custom Logic Editor in PowerSuite software to create a new, custom operating mode. To create a custom operating mode, select any pre-defined operating mode, then edit its code to meet the needs of your application.

Using the Custom Logic Editor, you can:

- access and read the data from pre-defined parameters
- add pre-defined parameters to the custom operating mode
- create new calculated parameters, derived from pre-defined parameters
- create new monitoring functions, based on pre-defined or calculated parameters.

Measurements

Characteristics The measurement functions have the following characteristics:

Measurements	Accuracy[1]	LTM R controller	LTM R controller with expansion module	Value saved on power loss
Line currents	• 1% for 8 A and 27 A units • 2% for 100 A units	X	X	No
Ground current - internal	5...15% for ground current greater than: • 0.1 A on 8 A units • 0.2 A on 27 A units • 0.3 A on 100 A units	X	X	No
Ground current - external	greater of 5% or 0.01 A	X	X	No
Average current	• 1% for 8 A and 27 A units • 2% for 100 A units	X	X	No
Current phase imbalance	• 1.5% for 8 A and 27 A units • 3% for 100 A units	X	X	No
Thermal capacity level	1%	X	X	No
Motor temperature sensor	2%	X	X	No
Frequency	2%	–	X	No
Line-to-line voltage	1%	–	X	No
Line voltage imbalance	1.5%	–	X	No
Average voltage	1%	–	X	No
Active power	5%	–	X	No
Reactive power	5%	–	X	No
Power factor	3% (for $\cos \varphi \geq 0.6$)	–	X	No
Active power consumption	5%	–	X	Yes
Reactive power consumption	5%	–	X	Yes
X = the functionality is available with the units indicated – = the functionality is not available with the units indicated N/A = Not applicable				
1. Note: The accuracy levels presented in this table are typical accuracy levels. Actual accuracy levels may be lower or greater than these values.				

Fault and Warning Counters

Characteristics The fault and warning counting functions have the following characteristics:

Statistics	LTM R controller	LTM R controller with expansion module	Value saved on power loss
All Faults counter	X	X	Yes
All Warnings counter	X	X	Yes
Auto-Resets counter	X	X	Yes
Protection Fault counters	X	X	Yes
Control Command Diagnostic Fault counter	X	X	Yes
Wiring Error counters	X	X	Yes
Communication Loss Faults counter	X	X	Yes
Internal Faults counter	X	X	Yes
Fault history	X	X	Yes
X = the functionality is available with the units indicated – = the functionality is not available with the units indicated			

System and Device Monitoring Faults

Characteristics The system and device monitoring faults have the following characteristics:

Diagnostic faults	**LTM R controller**	**LTM R controller with expansion module**	**Value saved on power loss**
Internal watchdog faults	X	X	No
Controller internal temperature	X	X	No
Temperature sensor connections	X	X	No
Current transformer connections	X	X	No
Voltage transformer connections	-	X	No
Control command diagnostics (start check, stop check, run check back, and stop check back)	X	X	No
Control configuration checksum	X	X	No
Communication loss	X	X	Yes
X = the functionality is available with the units indicated – = the functionality is not available with the units indicated			

Motor History

Characteristics Motor history includes the following characteristics:

Motor statistics	LTM R controller	LTM R controller with expansion module	Value saved on power loss
Motor starts count	X	X	Yes
Motor LO1 starts count (logic output O.1 starts)	X	X	Yes
Motor LO2 starts count (logic output O.2 starts)	X	X	Yes
Motor starts per hour count	X	X	Yes
Load sheddings	X	X	Yes
Last start max current	X	X	Yes
Last start duration	X	X	No
Operating time	X	X	No
Max internal controller temperature	X	X	No
X = the functionality is available with the units indicated – = the functionality is not available with the units indicated			

Thermal Overload Statistics

Characteristics The thermal overload statistics have the following characteristics:

Thermal overload display parameters	LTM R controller	LTM R controller with expansion module	Value saved on power loss
Time to trip	X	X	No
Time to reset	X	X	No
X = the functionality is available with the units indicated – = the functionality is not available with the units indicated			

System Operating Status

Characteristics The system operating status has the following characteristics:

System operating status	LTM R controller	LTM R controller with expansion module	Value saved on power loss
Motor Running	X	X	No
On	X	X	No
Ready	X	X	No
Fault	X	X	No
Warning	X	X	No
X = the functionality is available with the units indicated – = the functionality is not available with the units indicated			

3.2 Measurements

Overview

Introduction

The LTM R controller and the expansion module record real time measurements or calculated values from current, voltage, or temperature analog inputs.
The LTM R controller uses these measurements to perform protection, control, monitoring, and logic functions. Each measurement is described in detail in this section.

Data Access

The measurements may be accessed via:

- a PC with PowerSuite™ software
- the Magelis® XBTN410 HMI device
- a PLC via the remote communication link

What's in this Section?

This section contains the following topics:

Topic	Page
Line Currents	69
Ground Current	71
Average Current	74
Current Phase Imbalance	76
Thermal Capacity Level	77
Motor Temperature Sensor	79
Frequency	79
Line-to-Line Voltages	80
Line Voltage Imbalance	81
Average Voltage	82
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Reactive Power	84
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Reactive Power Consumption	87

Line Currents

Description

The LTM R controller measures line currents and provides the value of each phase in amperes and as a percentage of FLC.

Line Currents

The line currents function returns the rms value in amperes of the phase currents from the 3 CT inputs:

- L1: phase 1 current
- L2: phase 2 current
- L3: phase 3 current

The LTM R controller performs true rms calculations for line currents up to the 7th harmonic.

Single-phase current is measured from L1 and L3.

Line Current Characteristics

The line currents function has the following characteristics:

Characteristic	Value
Unit	A
Accuracy	• 1% for 8 A and 27 A units • 2% for 100 A units
Resolution	0.01A
Refresh interval	100 ms

Line Current Ratio

The L1, L2, and L3 Current Ratio parameter provides the phase current as a percentage of FLC.

Line Current Ratio Formulas

The line current value for the phase is compared to the FLC parameter setting, where FLC is FLC1 or FLC2, whichever is active at that time.

Calculated measurement	Formula
Line current ratio	%FLC = 100 x Ln / FLC
Where: • FLC = FLC1 or FLC2 parameter setting, whichever is active at the time • Ln = L1, L2 or L3 current value in amperes	

Line Current Ratio Characteristics

The line current ratio function has the following characteristics:

Characteristic	Value
Unit	% of FLC
Accuracy	See *p. 69*
Resolution	1% FLC
Refresh interval	100 ms

Ground Current

Description

The LTM R controller measures ground currents and provides values in amperes and as a percentage of FLCmin.

The internal ground current is a measured value and reports 0 when the current falls below 10% of FLCmin. The external ground current depends on the parameter settings and reports the calculated value at any current level.

Ground Current

The ground current function returns the value of the ground current.

The ground current is either calculated by the LTM R controller from the 3 line currents measured by the load current transformers (I0Σ) or measured by the external ground current transformer (I0).

Configurable Parameters

The control mode configuration has the following configurable parameter setting:

Parameter	Setting range	Factory setting
Ground Current Mode	• Internal • External	Internal
Ground Current Ratio	• None • 100:1 • 200:1.5 • 1000:1 • 2000:1 • OtherRatio	None
Ground CT Primary	• 1…65535	1
Ground CT Secondary	• 1…65535	1

External Ground Current Formula

The external ground current value depends on the parameter settings:

Calculated measurement	Formula
External ground current	Ground CT Secondary x Ground CT Primary / Ground CT Secondary

Ground Current Characteristics

The ground current function has the following characteristics:

Characteristic		Value	
		Internal ground current (I0Σ)	**External ground current (I0)**
Unit		A	A
Accuracy			
LTM R 08xxx	Igr>= 0.3A	5%	the greater of 5% or 0.01A
	0.2A<=Igr<= 0.3A	10%	
	0.1A<=Igr<= 0.2A	15%	
	Igr< 0.1A	N/A[1]	
LTM R 27xxx	Igr>= 0.5 A	5%	
	0.3A<=Igr<= 0.5A	10%	
	0.2A<=Igr<= 0.3A	15%	
	Igr< 0.2A	N/A[1]	
LTM R 100xxx	Igr>= 1.0A	5%	
	0.5A<=Igr<= 1.0A	10%	
	0.3A<=Igr<= 0.5A	15%	
	Igr< 0.3A	N/A[1]	
Resolution		0.01A	0.01A
Refresh interval		100 ms	100 ms

1. For currents of this magitude or lower, the internal ground current function should not be used. Instead, use external ground current transformers.

Ground Current Ratio

The Ground Current Ratio parameter provides the ground current value as a percentage of FLCmin.

Ground Current Ratio Formulas

The ground current value is compared to FLCmin.

Calculated measurement	Formula
Ground current ratio	100 x ground current / FLCmin

Ground Current Ratio Characteristics

The ground current ratio function has the following characteristics:

Characteristic	Value
Unit	0…2000% of FLCmin
Accuracy	See ground current characteristics, above.
Resolution	0.1% FLCmin
Refresh interval	100 ms

Average Current

Description

The LTM R controller calculates average current and provides the value for phase in amperes and as a percentage of FLC.

Average Current

The average current function returns the rms value of the average current.

Average Current Formulas

The LTM R controller calculates the average current using the measured line currents. The measured values are internally summed using the following formula:

Calculated measurement	Formula
Average current, three-phase motor	Iavg = (L1 + L2 + L3) / 3
Average current, single-phase motor	Iavg = (L1 + L3) / 2

Average Current Characteristics

The average current function has the following characteristics:

Characteristic	Value
Unit	A
Accuracy	• 1% for 8 A and 27 A units • 2% for 100 A units
Resolution	0.01A
Refresh interval	100 ms

Average Current Ratio

The Average Current Ratio parameter provides the average current value as a percentage of FLC.

Average Current Ratio Formulas

The average current value for the phase is compared to the FLC parameter setting, where FLC is FLC1 or FLC2, whichever is active at that time.

Calculated measurement	Formula
Line current ratio	% FLC = 100 x Iavg / FLC
Where: • FLC = FLC1 or FLC2 parameter setting, whichever is active at the time • Iavg = average current value in amperes	

Average Current Ratio Characteristics

The average current ratio function has the following characteristics:

Characteristic	Value
Unit	% of FLC
Accuracy	See average current, above.
Resolution	1% FLC
Refresh interval	100 ms

Current Phase Imbalance

Description

The current phase imbalance function measures the maximum percentage of deviation between the average current and the individual phase currents.

Formulas

The current phase imbalance measurement is based on imbalance ratio calculated from the following formulas:

Calculated measurement	Formula
Imbalance ratio of current in phase 1 (in %)	Ii1 = (| L1 - Iavg | x 100) / Iavg
Imbalance ratio of current in phase 2 (in %)	Ii2 = (| L2 - Iavg | x 100) / Iavg
Imbalance ratio of current in phase 3 (in %)	Ii3 = (| L3 - Iavg | x 100) / Iavg
Current imbalance ratio for three-phase (in %)	Iimb = Max(Ii1, Ii2, Ii3)

Characteristics

The line current imbalance function has the following characteristics:

Characteristic	Value
Unit	%
Accuracy	• 1.5% for 8 A and 27 A units • 3% for 100 A units
Resolution	1%
Refresh interval	100 ms

Thermal Capacity Level

Description

The thermal capacity level function calculates the amount of thermal capacity used and estimates the amount of time remaining until a fault condition is reached. Refer to *Time to Trip, p. 112*. After a fault, this function estimates the thermal capacity and time required for the motor to cool calculations. Refer to *Minimum Wait Time, p. 114*. This function uses two thermal models: one for copper stator and rotor windings of the motor and the other for the iron frame of the motor. The thermal model with the maximum utilized capacity is reported.

This function also estimates and displays:

- the time remaining before a thermal overload fault is triggered, and
- the time remaining until the fault condition is cleared–after a thermal overload fault has been triggered.

Trip Current Characteristics

The Thermal Capacity level function uses one of the following selected trip current characteristics (TCCs):

- definite time
- inverse thermal (default)

Thermal Capacity Models

Both copper and iron models use the maximum measured phase current and the Motor trip class parameter value to generate a non-scaled thermal image. The reported thermal capacity level is calculated by scaling the thermal image to FLC.

Formulas

The thermal capacity level calculated measurement is based on the following formulas:

Calculated measurement	Model	Formula
Thermal capacity model	copper thermal Image non-scaled	$\theta cu = Imax^2 \times (1 - e^{-t/(TC \times 17.79)})$
	iron thermal Image non-scaled	$\theta fe = Imax^2 \times (1 - e^{-t/(TC \times 58.71)})$
Reported Thermal capacity level	copper thermal Image scaled	$\theta cu\% = (\theta cu) / (FLC \times 1.414)^2$
	iron thermal Image scaled	$\theta fe\% = (\theta fe) / (FLC \times 1.125)^2$

Where:

- θcu = Non-scaled copper thermal image
- Imax = Maximum phase current
- e = Euler's constant = 2.71828...
- t = Time
- TC = Motor trip class value
- 17.79 = Copper trip class constant
- θfe = Non-scaled iron thermal image
- 58.71 = Iron trip class constant
- $\theta cu\%$ = Scaled copper thermal image
- FLC = Full load current parameter value (FLC1 or FLC2)
- $\theta fe\%$ = Scaled iron thermal image

Characteristics

The thermal capacity function has the following characteristics:

Characteristic	Value
Unit	%
Accuracy	+/–1%
Resolution	1%
Refresh interval	100 ms

Motor Temperature Sensor

Description

The motor temperature sensor function displays the resistance value in ohms measured by resistance temperature sensor. Refer to the product documentation for the specific temperature sensor being used. One of three types of temperature sensors can be used:

- PTC Binary
- PTC Analog
- NTC Analog

Characteristics

The motor temperature sensor function has the following characteristics:

Characteristic	Value
Unit	Ω
Accuracy	2%
Resolution	0.1 Ω
Refresh interval	500 ms

Frequency

Description

The frequency function displays the value measured based on the line voltage measurements.

Characteristics

The frequency function has the following characteristics:

Characteristic	Value
Unit	Hz
Accuracy	+/–2%
Resolution	0.1 Hz
Refresh interval	30 ms

Line-to-Line Voltages

Description

The line-to-line voltages function displays the rms value of the phase-to-phase voltage (V1 to V2, V2 to V3, and V3 to V1):

- L1-L2 voltage: phase 1 to phase 2 voltage
- L2-L3 voltage: phase 2 to phase 3 voltage
- L3-L1 voltage: phase 3 to phase 1 voltage

The expansion module performs true rms calculations for line-to-line voltage up to the 7th harmonic.

Single phase voltage is measured from L1 and L3.

Characteristics

The line-to-line voltages function has the following characteristics:

Characteristic	Value
Unit	Vac
Accuracy	1 %
Resolution	1 Vac
Refresh interval	100 ms

Line Voltage Imbalance

Description

The line voltage imbalance function displays the maximum percentage of deviation between the average voltage and the individual line voltages.

Formulas

The line voltage imbalance calculated measurement is based on the following formulas:

Calculated measurement	Formula
Imbalance ratio of voltage in phase 1 in %	Vi1 = 100 x | V1 - Vavg | / Vavg
Imbalance ratio of voltage in phase 2 in %	Vi2 = 100 x | V2 - Vavg | / Vavg
Imbalance ratio of voltage in phase 3 in %	Vi3 = 100 x | V3 - Vavg | / Vavg
Voltage imbalance ratio for three-phase in %	Vimb = Max (Vi1, Vi2, Vi3)
Where: • V1 = L1-L2 voltage (phase 1 to phase 2 voltage) • V2 = L2-L3 voltage (phase 2 to phase 3 voltage) • V3 = L3-L1 voltage (phase 3 to phase 1 voltage) • Vavg = average voltage	

Characteristics

The line voltage imbalance function has the following characteristics:

Characteristic	Value
Unit	%
Accuracy	1.5%
Resolution	1%
Refresh interval	100 ms

Average Voltage

Description

The LTM R controller calculates average voltage and provides the value in volts. The average voltage function returns the rms value of the average voltage.

Average Voltage Formulas

The LTM R controller calculates average voltage using the measured line-to-line voltages. The measured values are internally summed using the following formula:

Calculated measurement	Formula
Average voltage, 3-phase motor	Vavg = (L1-L2 voltage + L2-L3 voltage + L3-L1 voltage) / 3
Average voltage, single-phase motor	Vavg = L3-L1 voltage

Average Voltage Characteristics

The average voltage function has the following characteristics:

Characteristic	Value
Unit	Vac
Accuracy	1%
Resolution	1 Vac
Refresh interval	100 ms

Active Power

Description

The active power function measures the active power based on the:

- average rms phase voltage of L1, L2, L3
- average rms phase current of L1, L2, L3
- power factor
- number of phases

Formulas

Active Power—also known as *true power*—measures Average rms Power. It is expressed in watts and is the product of:

Calculated measurement	Formula
Active power (P) for 3-phase motor	P = √3 x Iavg x Vavg x PF
Active power (P) for single-phase motor	P = Iavg x Vavg x PF
where: • Iavg = Average rms current • Vavg = Average rms voltage • P = Active power • PF = Power factor	

Characteristics

The active power function has the following characteristics:

Characteristic	Value
Unit	kW
Accuracy	5%
Resolution	0.1 kW
Refresh interval	100 ms

Reactive Power

Description

The reactive power function measures the reactive power based on the:

- average rms phase voltage of L1, L2, L3
- average rms phase current of L1, L2, L3
- power factor
- number of phases

Formulas

The reactive power measurement is derived from the following formulas:

Calculated measurement	Formula
Q Reactive Power for three-phase motor	Q = $\sqrt{3}$ x Iavg x Vavg x sin φ
Q Reactive Power for single-phase motor	Q = Iavg x Vavg x sin φ

Characteristics

The reactive power function has the following characteristics:

Characteristic	Value
Unit	kvar
Accuracy	5%
Resolution	0.1 kvar
Refresh interval	100 ms

Power Factor

Description

The power factor function displays the phase displacement between the phase currents and phase voltages.

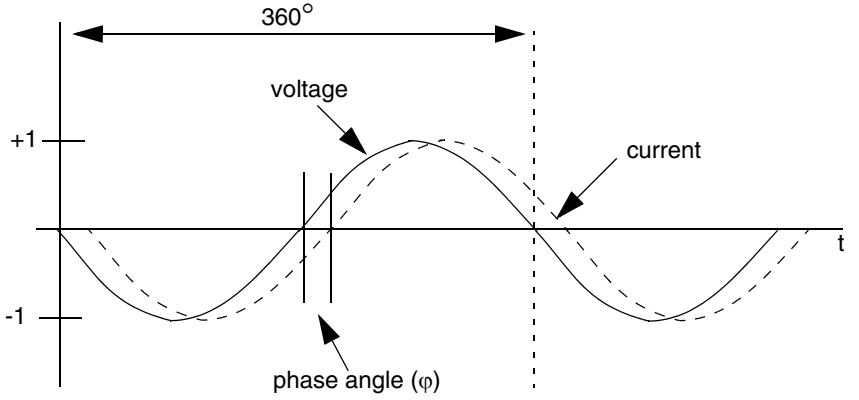
Formula

The Power Factor parameter—also called cosine phi (or cos φ)—represents the absolute value of the ratio of Active Power to Apparent Power.

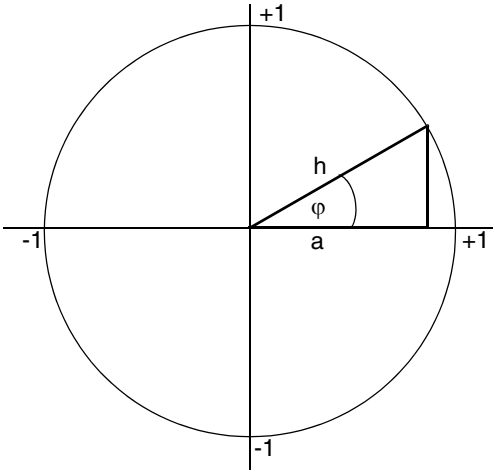
The LTM R controller independently calculates the power factor, as follows:

Step	LTM R controller action
1	Measures the time difference between the x-axis zero crossings of the voltage and current sinusoidal waveforms.
2	Converts this measured time difference to a phase angle (φ) in degrees.
3	Calculates the absolute value of the cosine of the phase angle (φ).

The following diagram displays an example of the average rms current sinusoidal curve lagging slightly behind the average rms voltage sinusoidal curve, and the phase angle difference between the two curves:



After the phase angle (φ) is measured, the power factor can be calculated as the cosine of the phase angle (φ)—the ratio of side a (Active Power) over the hypotenuse h (Apparent Power):



Characteristics

The active power function has the following characteristics:

Characteristic	Value
Accuracy	3% for $\cos \varphi \geq 0.6$
Resolution	0.01
Refresh interval	30 ms (typical) [1]
1. The refresh interval depends on the frequency.	

Active Power Consumption

Description

The active power consumption function displays the accumulated total of the active electrical power delivered, and used or consumed by the load.

Characteristics

The active power consumption function has the following characteristics:

Characteristic	Value
Unit	kWh
Accuracy	5%
Resolution	0.1 kWh
Refresh interval	100 ms

Reactive Power Consumption

Description

The reactive power consumption function displays the accumulated total of the reactive electrical power delivered, and used or consumed by the load.

Characteristics

The reactive power consumption function has the following characteristics:

Characteristic	Value
Unit	kvarh
Accuracy	5%
Resolution	0.1 kvarh
Refresh interval	100 ms

3.3 Fault and Warning Counters

Overview

Introduction

The LTM R controller counts and records the number of faults and warnings that occur. In addition, it counts the number of auto-reset attempts. This information can be accessed to assist with system performance and maintenance.

Access Data

Fault and warning counters may be accessed via:

- a PC with PowerSuite™ software
- the Magelis® XBTN410 HMI device
- a PLC via the remote communication link

What's in this Section?

This section contains the following topics:

Topic	Page
Introducing Fault and Warning Counters	89
All Faults Counter	90
All Warnings Counter	90
Auto-Reset Counter	90
Protection Faults and Warnings Counters	91
Control Command Errors Counter	92
Wiring Faults Counter	92
Communication Loss Counters	93
Internal Fault Counters	93
Fault History	94

Introducing Fault and Warning Counters

Overview

The LTM R controller records the number of faults and warnings that it detects. It also records the number of times an attempted fault auto-reset was unsuccessful.

Detecting Faults

Before the LTM R controller will detect a fault, certain preconditions must exist. These conditions can include:

- the fault detecting function must be enabled
- a monitored value–for example, current, voltage, or thermal resistance–must rise above, or fall below, a threshold setting
- the monitored value must remain above or below the threshold setting for a specified time duration

If all preconditions are satisfied, the LTM R controller detects a fault or warning.

Detecting Warnings

If a warning detection function is enabled, the LTM R controller detects a warning immediately when the monitored value rises above, or falls below, a threshold setting.

Counters

When the LTM R controller detects a fault or warning, or when a fault is automatically reset, the LTM R controller records that fact by incrementing one or more counters. A counter contains a value from 0 to 65535 and increments by a value of 1 when a fault, warning or reset event occurs. A counter stops incrementing when it reaches a value of 65535.

When a fault occurs, the LTM R controller increments at least 2 counters:

- a counter for the specific fault detecting function, and
- a counter for all faults

When a warning occurs, the LTM R controller increments a single counter for all warnings. However, when the LTM R controller detects a thermal overload warning, it also increments the thermal overload warnings counter.

When a fault is automatically reset, the LTM R controller increments only the auto-resets counter.

Clearing Counters

All fault and warning counters are reset to 0 by executing the Clear Statistics Command.

All Faults Counter

Description

The Faults Count parameter contains the number of faults that have occurred since the Clear All Statistics Command last executed.

The Faults Count parameter increments by a value of 1 when the LTM R controller detects any fault.

All Warnings Counter

Description

The Warnings Count parameter contains the number of warnings that have occurred since the Clear All Statistics Command last executed.

The Warnings Count parameter increments by a value of 1 when the LTM R controller detects any warning.

Auto-Reset Counter

Description

The Auto-Reset Count parameter contains the number of times the LTM R controller attempted–but failed–to auto-reset a fault.

The Auto-Reset Count parameter increments by a value of 1 each time the LTM R controller unsuccessfully attempts to auto-reset a fault. If an auto-reset attempt is successful (defined as the same fault not recurring within 60 s), this counter is reset to zero. If a fault is reset either manually or remotely, the counter is not incremented.

For information on fault management, see *p. 253*.

Protection Faults and Warnings Counters

Protection Fault Counts

Each protection function has a counter that contains the total number of faults, for that protection function, that occurred since the Clear Statistics Command last executed. Protection function counters include:

- Current Phase Imbalance Faults Count
- Current Phase Loss Faults Count
- Current Phase Reversal Faults Count
- Ground Current Faults Count
- Jam Faults Count
- Long Start Faults Count
- Motor Temp Sensor Faults Count
- Over Power Factor Faults Count
- Overcurrent Faults Count
- Overpower Faults Count
- Overvoltage Faults Count
- Thermal Overload Faults Count
- Under Power Factor Faults Count
- Undercurrent Faults Count
- Underpower Faults Count
- Undervoltage Faults Count
- Voltage Phase Imbalance Faults Count
- Voltage Phase Loss Faults Count
- Voltage Phase Reversal Faults Count

When the LTM R controller increments any of the above protection function counters, it also increments the Faults Count parameter.

Protection Warning Counts

The Thermal Overload Warnings Count parameter contains the total number of warnings for the thermal overload protection function.

When any warning occurs, including a thermal overload warning, the LTM R controller increments the Warnings Count parameter.

Control Command Errors Counter

Description

The Diagnostic Faults Count parameter contains the total number of Diagnostic Faults that occurred since the Clear All Statistics Command last executed.

A Diagnostic Fault occurs when the LTM R controller detects any of the following control command errors:

- Start Command Check errors
- Stop Command Check errors
- Stop Check Back errors
- Run Check Back errors

For information on these control command functions, see *p. 99*

When the LTM R controller increments the Diagnostic Faults Count parameter, it also increments the Faults Count parameter.

Wiring Faults Counter

Description

The Wiring Faults Count parameter contains the total number of the following wiring faults that have occurred since the Clear Statistics Command last executed:

- Wiring Fault, which is triggered by a:
  - CT Reversal Error
  - Phase Configuration Error
  - Motor Temperature Sensor Wiring Error
- Voltage Phase Reversal Fault
- Current Phase Reversal Fault

The LTM R controller increments the Wiring Faults Count parameter by a value of 1 each time any one of the above 3 faults occurs. For information on connection errors and related faults, see *p. 102*.

When the LTM R controller increments the Wiring Faults Count parameter, it also increments the Faults Count parameter.

Communication Loss Counters

Description

The LTM R controller records the total number of faults detected since the Clear Statistics Command last executed, for the following communication functions:

Counter	Contains
HMI Port Faults Count	The number of times communications via the HMI port was lost.
Network Port Internal Faults Count	The number of internal faults experienced by the network module, reported by the network module to the LTM R controller.
Network Port Config Faults Count	The number of major faults experienced by the network module, exclusive of network module internal faults, reported by the network module to the LTM R controller.
Network Port Faults Count	The number of times communicaitons via the network port was lost.

When the LTM R controller increments any of the above communication loss counters, it also increments the Faults Count parameter.

Internal Fault Counters

Description

The LTM R controller records the total number of the faults detected since the Clear Statistics Command last executed, for the following internal faults:

Counter	Contains
Controller Internal Faults Count	The number of major and minor internal faults. For information on internal faults, see *p. 96*
Internal Port Faults Count	The number of LTM R controller internal communication faults, plus the number of failed attempts to identify the network communication module.

When the LTM R controller increments either of the above internal fault counters, it also increments the Faults Count parameter.

Fault History

Fault History

The LTM R controller stores a history of LTM R controller data that was recorded at the time of the last five detected faults. Fault n-0 contains the most recent fault record, and fault n-4 contains the oldest retained fault record.

Each fault record includes:

- Fault Code
- Date and Time
- Value of Settings
  - Motor Full Load Current Ratio (% of FLCmax)
- Value of Measurements
  - Thermal Capacity Level
  - Average Current Ratio
  - L1, L2, L3 Current Ratio
  - Ground Current Ratio
  - Full Load Current Max
  - Current Phase Imbalance
  - Voltage Phase Imbalance
  - Power Factor
  - Frequency
  - Motor Temp Sensor
  - Average Voltage
  - L3-L1 Voltage, L1-L2 Voltage, L2-L3 Voltage
  - Active Power

3.4 System and Device Monitoring Faults

Overview

Introduction

The LTM R controller and the expansion module detect faults which affect the LTM R controller's ability to work properly (internal controller check and check of communications, wiring and configuration errors).

Access

The system and device monitoring fault records may be accessed via:

- a PC with PowerSuite™ software
- a Magelis® XBTN410 HMI
- a PLC via the remote communication link

What's in this Section?

This section contains the following topics:

Topic	Page
Controller Internal Fault	96
Controller Internal Temperature	97
Control Command Diagnostic Errors	99
Wiring Faults	102
Controller Configuration Checksum	105
Communication Loss	105

Controller Internal Fault

Description

The LTM R controller detects and records faults that are internal to the device itself. Internal faults can be either major or minor. Major and minor faults can change the state of output relays. Cycling power to the LTM R controller may clear an internal fault.

When an internal fault occurs, the Controller Internal Fault parameter is set.

Major Internal Faults

During a major fault, the LTM R controller is unable to reliably execute its own programming and can only attempt to shut itself down. During a major fault, communication with the LTM R controller is not possible. Major internal faults include:

- stack overflow fault
- stack underflow fault
- watchdog time out
- ROM checksum failure
- CPU failure
- internal temperature fault (at 100 °C / 212 °F)
- RAM test error

Minor Internal Faults

Minor internal faults indicate that the data being provided to the LTM R controller is unreliable and protection could be compromised. During a minor fault, the LTM R controller continues to attempt to monitor status and communications, but does not accept any start commands. During a minor fault condition, the LTM R controller continues to detect and report major faults, but not additional minor faults. Minor internal faults include:

- internal network communications failure
- EEPROM error
- A/D out of range error
- Reset button stuck
- internal temperature fault (at 85 °C / 185 °F)
- invalid configuration error (conflicting configuration)
- improper logic function action (for example, attempting to write to a read-only parameter

Controller Internal Temperature

Description

The LTM R controller monitors its internal temperature, and reports warning, minor fault, and major fault conditions. Fault detection cannot be disabled. Warning detection can be enabled or disabled.

The internal temperature is not cleared when factory default settings are restored using the Clear All Command, or when statistics are reset using a Clear Statistics Command.

The controller retains a record of the highest attained internal temperature. For information about the Controller Internal Temperature Max parameter, see *p. 111*.

Characteristics

The Controller Internal Temperature measured values have the following characteristics:

Characteristic	Value
Unit	°C
Accuracy	+/- 4 °C (+/- 7.2 °F)
Resolution	1 °C (1.8 °F)
Refresh interval	100 ms

Parameters

The Controller Internal Temperature function includes one editable parameter:

Parameter	Setting range	Factory setting
Controller internal temperature warning enable	• Enable • Disable	Enable

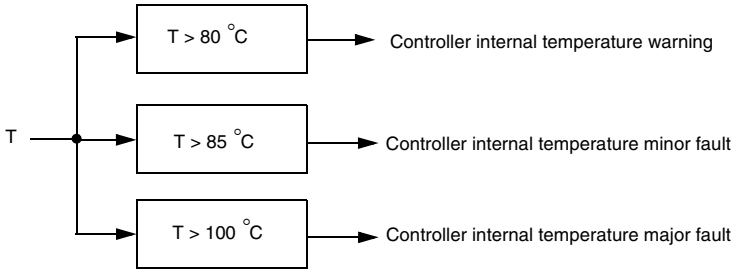
The Controller Internal Temperature function includes the following fixed warning and fault thresholds:

Condition	Fixed Threshold Value	Sets this parameter
Internal temperature warning	80 °C (176 °F)	Controller Internal Temperature Warning
Internal temperature minor fault	85 °C (185 °F)	Controller Internal Fault
Internal temperature major fault	100 °C (212 °F)	

A warning condition ceases when LTM R controller internal temperature falls below 80 °C.

Block Diagram

Controller Internal Temperature warning and fault:



T Temperature
T > 80 °C (176 °F) Fixed warning threshold
T > 85 °C (185 °F) Fixed minor fault threshold
T > 100 °C (212 °F) Fixed major fault threshold

Control Command Diagnostic Errors

Description

The LTM R controller performs diagnostic tests that detect and monitor the proper functionality of control commands.

There are four control command diagnostic functions:

- Start Command Check
- Run Check Back
- Stop Command Check
- Stop Check Back

Parameter Settings

All four diagnostic functions are enabled as a group. For each function a fault and warning can be enabled. The configurable parameter settings are:

Parameters	Setting range	Factory settings
Diagnostic Fault Enable	Yes/No	No
Diagnostic Warning Enable	Yes/No	No

Start Command Check

The Start Command Check begins after a Run command, and causes the LTM R controller to monitor the main circuit to ensure that current is flowing. The Start Command Check:

- reports a Start Command fault or warning, if current is not detected after a delay of 1 second, or
- ends, if the motor is in Run state and the LTM R controller detects current ≥ 10% of FLCmin

Run Check Back

The Run Check Back begins when the Start Command Check ends. The Run Check Back causes the LTM R controller to continuously monitor the main circuit to ensure current is flowing. The Run Check Back:

- reports a Run Check Back fault or warning if average phase current is not detected for longer than 0.5 seconds without a Stop command, or
- ends, when a Stop command executes

Stop Command Check

The Stop Command Check begins after a Stop command, and causes the LTM R controller to monitor the main circuit and ensure that no current is flowing.The Stop Command Check:

- reports a Stop Command fault or warning if current is detected after a delay of 1 second, or
- ends, if the LTM R controller detects current ≤ 5% of FLCmin

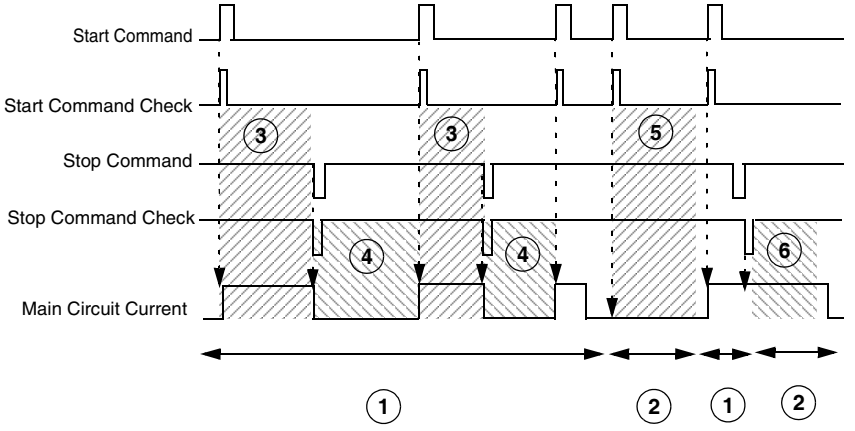
Stop Check Back

The Stop Check Back begins when the Stop Command Check ends. The Stop Check Back causes the LTM R controller to continuously monitor the main circuit to ensure no current is flowing. The Stop Check Back:

- reports a Stop Check Back fault or warning if average phase current is detected for longer than 0.5 seconds without a Run command, or
- ends, when a Run command executes

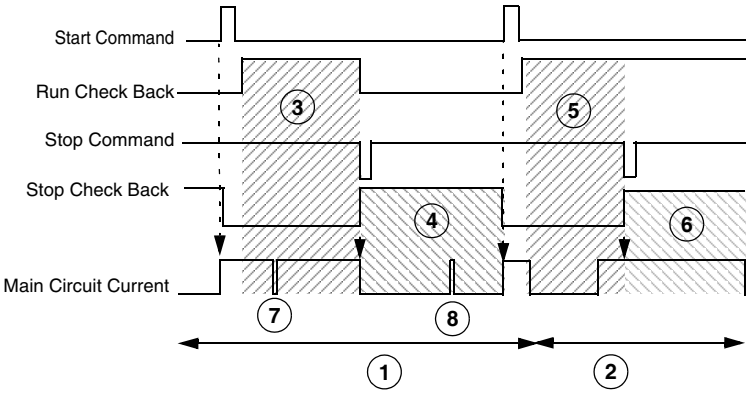
Timing Sequence

The following diagram is an example of the timing sequence for the Start Command Check and Stop Command Check:



1 Normal operation
2 Fault or warning condition
3 The LTM R controller monitors the main circuit to detect current
4 The LTM R controller monitors the main circuit to detect no current
5 The LTM R controller reports a Start Command Check fault and/or warning if current is not detected after 1 second
6 The LTM R controller reports a Stop Command Check fault and or warning if current is detected after 1 second

The following diagram is an example of the timing sequence for the Run Check Back and Stop Check Back:



1 Normal operation
2 Fault or warning condition
3 After the motor enters the run state, the LTM R controller continuously monitors the main circuit to detect current until a stop command is given or the function is disabled
4 The LTM R controller continuously monitors the main circuit to detect no current until a Start command is given or the function is disabled
5 The LTM R controller reports a Run Check Back fault and/or warning if the current is not detected for longer than 0.5 seconds without a Stop command
6 The LTM R controller reports a Stop Check Back fault or warning if the current is detected for longer than 0.5 seconds without a Start command
7 No current flowing for less than 0.5 seconds
8 Current flowing for less than 0.5 seconds

Wiring Faults

Description

The LTM R controller checks external wiring connections and reports a fault, when it detects incorrect or conflicting external wiring. The LTM R controller can detect the following 5 wiring errors:

- CT Reversal Error
- Phase Configuration Error
- Motor Temperature Sensor Wiring Error
- Voltage Phase Reversal Error
- Current Phase Reversal Error

Enabling Fault Detection

Wiring diagnostics are enabled using the following parameters:

Protection	Enabling parameters	Setting range	Factory setting	Fault reported
CT Reversal	Wiring Fault Enable	• Yes • No	No	Wiring Fault
Phase Configuration	• Motor Phases, if set to single-phase	• single-phase • 3-phase	3-phase	Wiring Fault
Motor Temperature Sensor Wiring	• Motor Temp Sensor Type, if set to a sensor type, and not to **None**	• None • PTC binary • PTC analog • NTC analog	None	Wiring Fault
Voltage Phase Reversal	Voltage Phase Reversal Fault Enable	• Yes • No	No	Voltage Phase Reversal Fault
Current Phase Reversal	Current Phase Reversal Fault Enable	• Yes • No	No	Current Phase Reversal Fault

CT Reversal Error

When individual external load CTs are used, they must all be installed in the same direction. The LTM R controller checks the CT wiring and reports an error if it detects one of the current transformers is wired backwards, when compared to the others.

This function can be enabled and disabled.

Phase Configuration Error

The LTM R controller checks all 3 motor phases for On Level current, then checks the Motor Phases parameter setting, The LTM R controller reports an error if it detects current in phase 2, if the LTM R controller is configured for single-phase operation.

This function is enabled when the LTM R controller is configured for single-phase operation. It has no configurable parameters.

Motor Temperature Sensor Error

When the LTM R controller is configured for motor temperature sensor protection, the LTM R controller provides short-circuit and open-circuit detection for the temperature sensing element.

The LTM R controller signals an error when:

- calculated resistance at the T1 and T2 terminals falls below the fixed short-circuit tripping threshold, or
- calculated resistance at the T1 and T2 terminals exceeds the fixed open-circuit tripping threshold

The LTM R controller clears the fault condition when the calculated resistance either falls below (open-circuit fault) or exceeds (short-circuit fault) a fixed re-closing threshold. After the fault condition has been cleared, the fault must be reset according to the configured Reset Mode: manual, automatic or remote.

Short-circuit and open-circuit fault thresholds are factory pre-set, are not configurable, and have no fault time delay. There are no warnings associated with the short-circuit and the open-circuit faults.

Short-circuit and open-circuit protection of the motor temperature sensing element is available for all operating states, for both single-phase and 3-phase motors.

This protection is enabled when a temperature sensor is employed and configured, and cannot be disabled.

The motor temperature sensor protection function has the following characteristics:

Characteristic	Value
Unit	Ω
Normal operating range	15…6500 Ω
Accuracy	at 15 Ω: +/-10% at 6500 Ω: +/-5%
Resolution	0.1 Ω
Refresh interval	100 ms

The fixed threshold settings for the open-circuit and short-circuit detection functions are:

Parameters	Setting for PTC Binary or PTC/NTC Analog	Accuracy
Short-circuit fault threshold	15 Ω	+/–10%
Short-circuit fault re-closing	20 Ω	+/–10%
Open-circuit fault threshold	6500 Ω	+/–5%
Open-circuit fault re-closing	6000 Ω	+/–5%

Voltage/Current Phase Reversal Error

Both the voltage and current phase reversal function signals a fault when it detects that either the voltage or the current phases of a 3-phase motor are out of sequence, indicating a wiring error. Use the Motor Phases Sequence parameter to set the phase sequence–ABC or ACB–and clear the error.

Note: When the LTM R controller is connected to an expansion module, phase reversal protection is based on voltage before the motor starts, and on current after the motor starts.

This protection:

- is active for voltage when:
  - the LTM R controller is connected to an expansion module, and
  - the LTM R controller is in ready state
- is active for current when the motor is in start state, run state, or fault state
- applies only to 3-phase motors
- has no warning and no timer

This function can be enabled or disabled.

Controller Configuration Checksum

Description

To verify that the software configuration has not been accidentally modified, the LTM R controller re-calculates checksums for the EEROM and FLASH memories. This check occurs at power-up and periodically thereafter. If the LTM R controller detects any variation, it reports a Controller Internal Fault.

Communication Loss

Description

The LTM R controller monitors communication through the:

- network port
- expansion module
- HMI, and
- local terminal connection

Network Port Parameter Settings

The LTM R controller monitors network communications and can report both a fault and a warning when network communications is lost. Both fault and warning monitoring are enabled by default.

The network port communications has the following configurable settings:

Parameter	Setting Range	Factory Default
Network port fault enable	Enable/Disable	Enable
Network port warning enable	Enable/Disable	Enable
Network port fallback setting [1]	• Hold • Run • O.1, O.2 off • O.1, O.2 on • O.1 off • O.2 off	O.1, O.2 off

1. The operating mode affects the configurable parameters for the network port fallback settings.

HMI Port Parameter Settings

The LTM R controller monitors HMI port communications and reports both a warning and a fault if no valid communication has been received by the HMI port for longer than 7 seconds.

Fault and warning monitoring can be enabled or disabled. Both fault and warning monitoring are enabled by default.

The HMI port communication has the following fixed and configurable settings:

Parameter	Setting Range	Factory Default
HMI port fault enable	Enable/Disable	Enable
HMI port warning enable	Enable/Disable	Enable
HMI port fallback setting [1]	• Hold • Run • O.1, O.2 off • O.1, O.2 on • O.1 off • O.2 off	O.1, O.2 off

1. The operating mode affects the configurable parameters for the HMI port fallback settings.

Fallback Condition

When communication between the LTM R controller and either the network or the local HMI is lost, the LTM R controller is in a fallback condition. The behavior of logic outputs O.1 and O.2 following a communication loss is determined by:

- the operating mode (see *p. 222*), and
- the Network Port Fallback Setting and HMI Port Fallback Setting parameters

Fallback setting selectings can include:

Port Fallback Setting	Description
Hold (O.1, O.2)	Directs the LTM R controller to hold the state of logic outputs O.1 and O.2 as of the time of the communication loss.
Run	Directs the LTM R controller to perform a Run command for a 2-step control sequence on the communication loss.
O.1, O.2 Off	Directs the LTM R controller to turn off both logic outputs O.1 and O.2 following a communication loss.
O.1, O.2 On	Directs the LTM R controller to turn on both logic outputs O.1 and O.2 following a communication loss.
O.1 On	Directs the LTM R controller to turn on only logic output O.1 following a communication loss.
O.2 On	Directs the LTM R controller to turn on only logic output O.2 following a communication loss.

The following table indicates which fallback options are available for each operating mode:

Port Fallback Setting	Operating Mode					
	Overload	Independent	Reverser	2-step	2-speed	Custom
Hold (O.1, O.2)	Yes	Yes	Yes	Yes	Yes	Yes
Run	No	No	No	Yes	No	No
O.1, O.2 Off	Yes	Yes	Yes	Yes	Yes	Yes
O.1, O.2 On	Yes	Yes	No	No	No	Yes
O.1 On	Yes	Yes	Yes	No	Yes	Yes
O.2 On	Yes	Yes	Yes	No	Yes	Yes

Note: When you select a network or HMI fallback setting, your selection must identify an active control source.

3.5 Motor History

Overview

Introduction

The LTM R controller tracks and saves motor operating statistics.

Access

Motor statistics can be accessed using:

- a PC with PowerSuite™ software
- a Magelis® XBTN410 HMI
- a PLC via the remote communication link

What's in this Section?

This section contains the following topics:

Topic	Page
Motor Starts	109
Motor Starts Per Hour	109
Load Sheddings Counter	110
Last Start Max Current	110
Last Start Time	110
Motor Operating Time	111
Maximum Internal Controller Temperature	111

Motor Starts

Description

The LTM R controller tracks motor starts and records the data as a statistic that can be retrieved for operational analysis. The following statistics are tracked:

- Motor Starts Count
- Motor LO1 Starts Count (logic output O.1 starts)
- Motor LO2 Starts Count (logic output O.2 starts)

The Clear Statistics Command resets the Motor Starts Count parameter to 0.

Note: The Motor LO1 Starts Count and Motor LO2 Starts Count parameters cannot be reset to 0, because these parameters together indicate the usage of the relay outputs usage over time.

Motor Starts Per Hour

Description

The LTM R controller tracks the number of motor starts during the past hour and records this figure in the Motor Starts Per Hour Count parameter.

The LTM R controller sums starts in 5 minute intervals with an accuracy of 1 interval (+0/– 5 minutes), which means that the parameter will contain the total number of starts within either the previous 60 minutes or the previous 55 minutes.

This function is used as a maintenance function to avoid thermal strain on the motor.

Characteristics

The motor starts per hour function has the following characteristics:

Characteristic	Value
Accuracy	5 minutes (+0/– 5 minutes)
Resolution	5 minutes
Refresh interval	100 ms

Load Sheddings Counter

Description

The Load Sheddings Count parameter contains the number of times the load sheddings protection function has been activated since the last Clear Statistics Command.

For information on the Load Sheddings protection function, see *p. 191*.

Last Start Max Current

Description

The LTM R controller measures the maximum current level reached during the last start of the motor and reports the value in the Motor Last Start Current Ratio parameter for analysis of the system for maintenance purposes.

Characteristics

The last start max current function has the following characteristics:

Characteristic	Value
Unit	% of FLC
Accuracy	• 1% for 8 A and 27 A units • 2% for 100 A units
Resolution	1% FLC
Refresh interval	100 ms

Last Start Time

Description

The LTM R controller tracks the duration of the last motor start and reports the value in the Motor Last Start Duration parameter for analysis of the system for maintenance purposes.

Characteristics

The motor last start duration function has the following characteristics:

Characteristic	Value
Unit	s
Accuracy	+/–1%
Resolution	1 s
Refresh interval	1 s

Motor Operating Time

Description

The LTM R controller tracks motor operating time and records the value in the Operating Time parameter. Use this information to help schedule motor maintenance, such as lubrication, inspection, and replacement.

Characteristics

The motor operating time function has the following characteristics:

Characteristic	Value
Unit	HHHHHHH:MM:SS
Accuracy	+/–30 minutes over 1 year of operation
Resolution	1 s
Refresh interval	1 s
Where: • H = Hours • M = Minutes • S = Seconds	

Maximum Internal Controller Temperature

Description

The Controller Internal Temperature Max parameter contains the highest internal temperature–expressed in °C–detected by the LTM R controller's internal temperature sensor. The LTM R controller updates this value whenever it detects an internal temperature greater than the current value.

For information about internal temperature measurement, including the detection of internal temperature faults and warnings, see *p. 97*.

Characteristics

The Controller Internal Temperature Max parameter has the following characteristics:

Characteristic	Value
Unit	°C
Accuracy	+/- 4 °C (+/- 7.2 °F)
Resolution	1 °C (1.8 °F)
Refresh interval	100 ms

3.6 Thermal Overload Statistics

Time to Trip

Description

When a thermal overload condition exists, the LTM R controller reports the time to trip before the fault occurs in the Time To Trip parameter.

When the LTM R controller is not in a thermal overload condition, to avoid the appearance of being in a fault state, the LTM R controller reports the time to trip as 9999.

If the motor has an auxiliary fan and the Motor Aux Fan Cooled parameter has been set, the time to reset is decreased by a factor of 4.

Characteristics

The time to trip function has the following characteristics:

Characteristic	Value
Unit	s
Accuracy	+/–10%
Resolution	1 s
Refresh interval	100 ms

3.7 System Operating Status

Overview

Introduction

The LTM R controller monitors the motor operating state and the minimum time required to wait for a:

- reset of a thermal fault
- auto reset delay timeout
- load shed reconnect delay, or
- rapid cycle timer timeout

If more than one timer is active, the parameter displays the maximum timer, which is the minimum wait for the fault response or the control function to reset.

Access

The Motor states can be accessed via:

- a PC with PowerSuite™ software
- a Magelis® XBTN410 HMI
- a PLC via the remote communication link

What's in this Section?

This section contains the following topics:

Topic	Page
Motor State	114
Minimum Wait Time	114

Motor State

Description

The LTM R controller tracks the motor state and reports the following states by setting the corresponding Boolean parameters:

State	Parameter
Motor running	Motor Running
On	System On
Ready	System Ready
Fault	System Fault
Warning	System Warning

Minimum Wait Time

Description

The LTM R controller tracks the time remaining to restart the motor according to one of the following events:

- auto-reset
- thermal overload
- rapid cycle
- load shedding

Faults can be assigned to auto-reset groups which have characteristics that control the time to reset the motor. For more details on the automatic fault reset mode, see *p. 260*.

Faults associated with thermal capacity are controlled by the motor characteristics that affect the time to reset the motor. For more details see *p. 77*.

Rapid cycle protects against harm caused by repetitive, successive inrush currents resulting from too little time between starts. See *p. 174* for more details.

Voltage load shedding controls the time to restart the motor following return of voltage after a load shed event. For more details see *p. 191*.

Characteristics

The Minimum Wait Time function has the following characteristics:

Characteristic	Value
Unit	s
Accuracy	+/–1%
Resolution	1 s
Refresh interval	1 s

Motor Protection Functions

4

At a Glance

Overview

This chapter describes the motor protection functions provided by the LTM R controller.

What's in this Chapter?

This chapter contains the following sections:

Section	Topic	Page
4.1	Motor Protection Functions Introduction	116
4.2	Thermal and Current Motor Protection Functions	129
4.3	Voltage Motor Protection Functions	176
4.4	Power Motor Protection Functions	194

4.1 Motor Protection Functions Introduction

At a Glance

Summary

This section introduces you to the motor protection functions provided by the LTM R controller, including protection parameters and characteristics.

What's in this Section?

This section contains the following topics:

Topic	Page
Motor Protection Functions	117
Setting Ranges of the Motor Protection Functions	119
Motor Protection Characteristics	125

Motor Protection Functions

Predefined Functions and Data

The LTM R controller monitors current, ground-current and motor temperature sensor parameters. When the LTM R controller is connected to an expansion module, the it also monitors voltage and power parameters. The LTM R controller uses these parameters in protection functions to detect fault and warning conditions.The LTM R controller's response to fault and warning conditions is fixed for the predefined operating modes. Logic output O.4 activates on a fault, and logic output O.3 activates on a warning. For more information about pre-defined operating modes, see *p. 222*.

You can configure these motor protection functions to detect the existence of undesirable operating conditions that, if not resolved, can cause motor and equipment damage.

All motor protection functions include fault detection, and most protection functions also include warning detection.

Customized Functions and Data

In addition to using the protection functions and parameters included in a pre-defined operating mode, you can use the Custom Logic Editor in PowerSuite™ software to create a new, customized operating mode. To create a custom operating mode, select any pre-defined operating mode, then edit its code to meet the needs of your application.

Using the Custom Logic Editor, you can create a customized operating mode by:

- modifying the LTM R controller's responses to protection faults or warnings
- creating new functions, based on either pre-defined or newly created parameters

Faults

A fault is a serious undesirable operating condition. Fault-related parameters can be configured for most protection functions.

The response of the LTM R controller to a fault include the following:

- output O.4 contacts:
  - contact 95-96 is open
  - contact 97-98 is closed
- fault LED is On and illuminates a steady red
- fault status bits are set in a fault parameter
- a text message is displayed in an HMI screen (if an HMI is attached)
- a fault status indicator is displayed in the configuration software.

The LTM R controller counts and records the number of faults for each protection function.

After a fault has occurred, merely resolving the underlying condition does not clear the fault. To clear the fault, the LTM R controller must be reset. See *p. 254*.

Warnings

A warning is a less-serious, though still undesirable, operating condition. A warning indicates corrective action may be required to prevent a problem condition from occurring. If left unresolved, a warning may lead to a fault condition. Warning-related parameters can be configured for most protection functions.

The response of the LTM R controller to a warning include the following:

- output O.3 is closed
- fault LED flashes red 2 times per second
- warning status bits are set in a warning parameter
- a text message is displayed in an HMI screen (if attached)
- a warning status indicator is displayed in the configuration software

Note: For some protection functions, warning detection shares the same threshold as fault detection. For other protection functions, warning detection has a separate warning threshold.

The LTM R controller clears the warning whenever the measured value no longer exceeds the warning threshold—plus or minus a 5% hysteresis band.

Setting Ranges of the Motor Protection Functions

⚠ WARNING

RISK OF UNINTENDED CONFIGURATION AND OPERATION

When modifying parameter settings of the LTM R controller:

- Be especially careful if you change parameter settings when the motor is running.
- Disable network control of the LTM R controller to prevent unintended parameter configuration and operation.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

Thermal and Current Protection Functions

The LTM R controller provides the thermal and current protection functions listed below. All the following functions can be enabled or disabled.

Protection functions	Parameters	Setting range	Factory setting
Thermal overload	Mode	• Inverse thermal • Definite time	Inverse thermal
	Fault reset mode	• Manual • Remote • Automatic	Manual
	Motor auxiliary fan cooled	Enable/Disable	Disable
	Fault enable	Enable/Disable	Enable
	Warning enable	Enable/Disable	Enable

1 Thermal Overload Inverse Thermal Fault Reset Timeout is set by the Auto Reset Group 1 Timeout parameter.

2 OC1 and OC2 are set via the Motor Full Load Current and the Motor High Speed Full Load Current parameters, respectively. OC1 and OC2 settings can be set directly–in Amperes–in the Settings menu of an HMI, or in the Settings branch of PowerSuite™ software.

3 Thermal Overload Definite Time D-Time is set by the Long Start Fault Timeout parameter.

Protection functions	Parameters	Setting range	Factory setting
Inverse thermal	Motor trip class	5...30 in increments of 5	5
	Fault threshold: • FLC1 (Motor full load current ratio), or • FLC2 (Motor high speed full load current ratio)	5...100% of FLCmax, in 1% increments.	5% FLCmax
	Warning threshold	10...100% of thermal capacity in 1% increments	85% of thermal capacity
	Fault reset timeout [1]	0...9999 s in 1 s increments	480 s
	Fault reset threshold	35...95% of thermal capacity	75% of thermal capacity
Definite time	OC1 or OC2[2]	5...100% of FLCmax, in 1% increments.	5% FLCmax
	Delay time (D-Time)[3]	1...200 s in increments of 1 s	10 s
	Overcurrent timeout (O-Time– set via the Thermal Overload Fault Definite Timeout parameter)	1...300 s in increments of 1 s	10 s
Current phase imbalance	Fault enable	Enable/Disable	Enable
	Fault timeout starting	0.2...20 s in 0.1 s increments	0.7 s
	Fault timeout running	0.2...20 s in 0.1 s increments	5 s
	Fault threshold	10...70% of the calculated imbalance	10%
	Warning enable	Enable/Disable	Disable
	Warning threshold	a calculated imbalance of 10...70%	10%
Current phase loss	Fault enable	Enable/Disable	Enable
	Timeout	0.1...30 s in 0.1 s increments	3 s
	Warning enable	Enable/Disable	Enable
Current phase reversal	Fault enable	Enable/Disable	Disable
	Phase sequence	• A-B-C • A-C-B	A-B-C

1 Thermal Overload Inverse Thermal Fault Reset Timeout is set by the Auto Reset Group 1 Timeout parameter.

2 OC1 and OC2 are set via the Motor Full Load Current and the Motor High Speed Full Load Current parameters, respectively. OC1 and OC2 settings can be set directly–in Amperes–in the Settings menu of an HMI, or in the Settings branch of PowerSuite™ software.

3 Thermal Overload Definite Time D-Time is set by the Long Start Fault Timeout parameter.

Protection functions	Parameters	Setting range	Factory setting
Long start (locked rotor at start)	Fault enable	Enable/Disable	Enable
	Fault timeout	1...200 s in 1 s increments	10 s
	Fault threshold	100...800% of FLC in 10% increments	100% of FLC
Jam (locked rotor during run)	Fault enable	Enable/Disable	Enable
	Fault timeout	1...30 s in 1 s increments	5 s
	Fault threshold	100...800% of FLC in 1% increments	200% of FLC
	Warning enable	Enable/Disable	Disable
	Warning threshold	100...800% of FLC in 1% increments	200% of FLC
Undercurrent	Fault enable	Enable/Disable	Disable
	Fault timeout	1...200 s in 1 s increments	10 s
	Fault threshold	30...100% of FLC in 1% increments	50% of FLC
	Warning enable	Enable/Disable	Disable
	Warning threshold	30...100% of FLC in 1% increments	50% of FLC
Overcurrent	Fault enable	Enable/Disable	Disable
	Fault timeout	1...250 s in 1 s increments	10 s
	Fault threshold	20...800% of FLC in 1% increments	80% of FLC
	Warning enable	Enable/Disable	Disable
	Warning threshold	20...800% of FLC in 1% increments	80% of FLC
Ground current	Ground Current Mode	• Internal • External	Internal
	Fault enable	Enable/Disable	Enable
	Warning enable	Enable/Disable	Enable
Internal ground current	Fault timeout	0.5...25 s in 0.1 s increments	1 s
	Fault threshold	20...500% of FLCmin in 1% increments	30% of FLCmin
	Warning threshold	20...500% of FLCmin in 1% increments	30% of FLCmin
External ground current	Fault timeout	0.1...25 s in 0.01 s increments	0.5 s
	Fault threshold	0.01...20 A in 0.01 A increments	1 A
	Warning threshold	0.01...20 A in 0.01 A increments	1 A

1 Thermal Overload Inverse Thermal Fault Reset Timeout is set by the Auto Reset Group 1 Timeout parameter.

2 OC1 and OC2 are set via the Motor Full Load Current and the Motor High Speed Full Load Current parameters, respectively. OC1 and OC2 settings can be set directly–in Amperes–in the Settings menu of an HMI, or in the Settings branch of PowerSuite™ software.

3 Thermal Overload Definite Time D-Time is set by the Long Start Fault Timeout parameter.

Protection functions	Parameters	Setting range	Factory setting
Motor temperature sensor	Type	• None • PTC Binary • PTC Analog • NTC Analog	None
	Fault enable	Enable/Disable	Disable
	Warning enable	Enable/Disable	Disable
PTC binary	(no configurable parameters)	-	-
PTC/NTC analog	Fault threshold	20...6500 Ω in 0.1 Ω increments	200 Ω
	Warning threshold	20...6500 Ω in 0.1 Ω increments	200 Ω
Rapid cycle lockout	Timeout	0...999.9 s in increments of 0.1 s	0 s

1 Thermal Overload Inverse Thermal Fault Reset Timeout is set by the Auto Reset Group 1 Timeout parameter.

2 OC1 and OC2 are set via the Motor Full Load Current and the Motor High Speed Full Load Current parameters, respectively. OC1 and OC2 settings can be set directly–in Amperes–in the Settings menu of an HMI, or in the Settings branch of PowerSuite™ software.

3 Thermal Overload Definite Time D-Time is set by the Long Start Fault Timeout parameter.

Voltage Protection Functions

When connected to an expansion module, the LTM R controller provides the additional voltage protection functions listed below. All of the following functions can be enabled or disabled.

Protection functions	Parameters	Setting range	Factory setting
Voltage phase imbalance	Fault enable	Enable/Disable	Disable
	Fault timeout starting	0.2...20 s in 0.1 s increments	0.7 s
	Fault timeout running	0.2...20 s in 0.1 s increments	2 s
	Fault threshold	3...15% of the calculated imbalance in 1% increments	10% imbalance
	Warning enable	Enable/Disable	Disable
	Warning threshold	3...15% calculated imbalance in 1% increments	10% imbalance
Voltage phase loss	Fault enable	Enable/Disable	Enable
	Fault timeout	0.1...30 s in 0.1 s increments	3 s
	Warning enable	Enable/Disable	Enable
Voltage phase reversal	Fault enable	Enable/Disable	Enable
	Motor phases sequence	• A-B-C • A-C-B	A-B-C
Undervoltage	Fault enable	Enable/Disable	Disable
	Fault timeout	0.2...25 s in 0.1 s increments	3 s
	Fault threshold	70... 99% of Motor nominal voltage in 1% increments	85% of Motor nominal voltage
	Warning enable	Enable/Disable	Disable
	Warning threshold	70... 99% of Motor nominal voltage in 1% increments	85% of Motor nominal voltage
Overvoltage	Fault enable	Enable/Disable	Disable
	Fault timeout	0.2...25 s in 0.1 s increments	3 s
	Fault threshold	101...115% of Motor nominal voltage in 1% increments	110% of Motor nominal voltage
	Warning enable	Enable/Disable	Disable
	Warning threshold	101...115% of Motor nominal voltage in 1% increments	110% of Motor nominal voltage
Load shedding	Enable	Enable/Disable	Enable
	Timeout	1...9999 s in increments of 0.1 s	10 s
	Threshold	68...115% of Motor nominal voltage	70%
	Restart timeout	1...9999 s in increments of 0.1 minutes	10 s
	Restart threshold	68...115% of Motor nominal voltage	90%

Power Protection Functions

When connected to an expansion module, the LTM R controller provides the additional power protection functions listed below. All of the following functions can be enabled or disabled.

Protection functions	Parameters	Setting range	Factory setting
Underpower	Fault enable	Enable/Disable	Disable
	Fault Timeout	1...100 s in 1 s increments	60 s
	Fault threshold	20...800% of Motor nominal power in 1% increments	20% of Motor nominal power
	Warning enable	Enable/Disable	Disable
	Warning threshold	20...800% of Motor nominal power in 1% increments	20% of Motor nominal power
Overpower	Fault enable	Enable/Disable	Disable
	Fault timeout	1...100 s in 1 s increments	60 s
	Fault threshold	20...800% of Motor nominal power in 1% increments	150% of Motor nominal power
	Warning enable	Enable/Disable	Disable
	Warning threshold	20...800% of Motor nominal power in 1% increments	150% of Motor nominal power
Under power factor	Fault enable	Enable/Disable	Disable
	Fault timeout	1...25 s in 0.1 s increments	10 s
	Fault threshold	0...1 in 0.01 increments	0.60
	Warning enable	Enable/Disable	Disable
	Warning threshold	0...1 in 0.01 increments	0.60
Over power factor	Fault enable	Enable/Disable	Disable
	Fault timeout	1...25 s in 0.1 s increments	10 s
	Fault threshold	0...1 in 0.01 increments	0.90
	Warning enable	Enable/Disable	Disable
	Warning threshold	0...1 in 0.01 increments	0.90

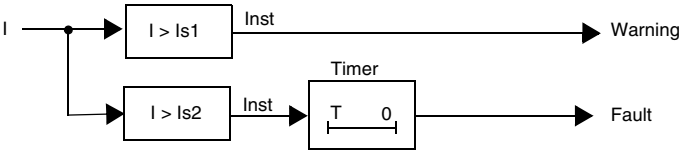
Motor Protection Characteristics

Overview

The protection functions of the LTM R controller continuously monitor the values of current parameters. When connected to an expansion module, the LTM R controller also provides voltage protection and monitors voltage and power parameters.

Operation

The following diagram describes the operation of a typical motor protection function. This diagram, and the following diagrams, are expressed in terms of current. However, the same principles apply to voltage.



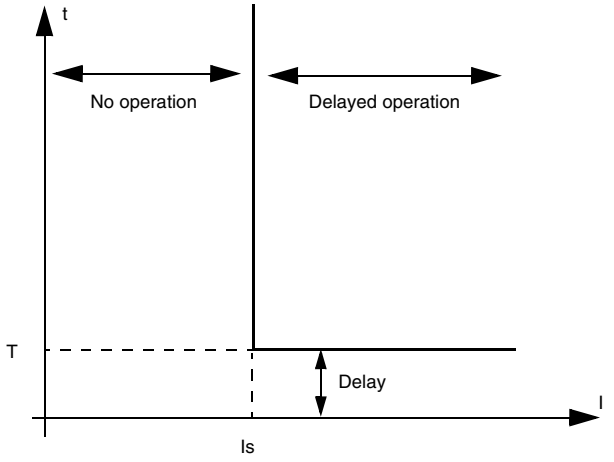
I Measurement of the monitored parameter
Is1 Warning threshold setting
Is2 Fault threshold setting
T Fault timeout setting
Inst Instantaneous warning/fault detection

Settings

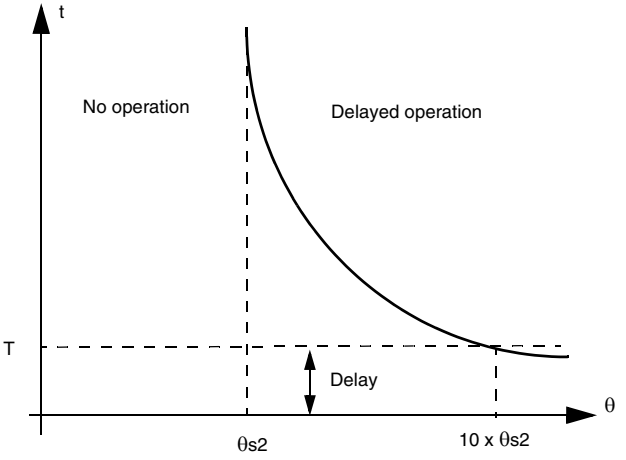
Some protection functions include configurable settings, including:

- Fault threshold: A limit setting for the monitored parameter that triggers a protection function fault.
- Warning threshold: A limit setting for the monitored parameter that triggers a protection function warning.
- Fault timeout: A time delay that must expire before the protection function fault is triggered. The behavior of a timeout depends on its trip current characteristic profile.
- Trip curve characteristic (TCC): The LTM R controller includes a definite trip characteristic for all protection functions, except the Thermal Overload Inverse Thermal protection function, which has both an inverse trip and definite trip curve characteristic, as described below:

Definite TCC: The duration of the fault timeout remains a constant regardless of changes in the value of the measured quantity (current), as described in the following diagram:



Inverse TCC: The duration of the time delay varies inversely with the value of the measured quantity (here, thermal capacity). As the measured quantity increases, the potential for harm also increases, thereby causing the duration of the time delay to decrease, as described in the following diagram:

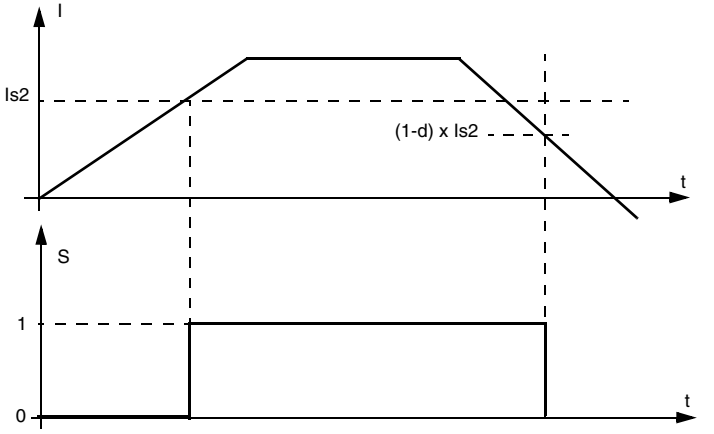


Hysteresis

To improve stability, motor protection functions apply a hysteresis value that is added to or subtracted from limit threshold settings before a fault or warning response is reset. The hysteresis value is calculated as a percentage—typically 5%—of the limit threshold and is:

- subtracted from the threshold value for upper limit thresholds
- added to the threshold value for lower limit thresholds.

The following diagram describes the logic result of measurement processing (S) when hysteresis is applied to an upper limit threshold:



d hysteresis percentage

4.2 Thermal and Current Motor Protection Functions

At a Glance

Summary

This section describes the thermal and current motor protection functions of the LTM R controller.

What's in this Section?

This section contains the following topics:

Topic	Page
Thermal Overload	130
Thermal Overload - Inverse Thermal	131
Thermal Overload - Definite Time	138
Current Phase Imbalance	141
Current Phase Loss	145
Current Phase Reversal	148
Long Start	149
Jam	152
Undercurrent	154
Overcurrent	156
Ground Current	159
Internal Ground Current	160
External Ground Current	163
Motor Temperature Sensor	166
Motor Temperature Sensor - PTC Binary	167
Motor Temperature Sensor - PTC Analog	169
Motor Temperature Sensor - NTC Analog	172
Rapid Cycle Lockout	174

Thermal Overload

Overview

The LTM R controller can be configured to provide thermal protection, by selecting one of the following settings:

- Inverse Thermal (default)
- Definite Time

Each setting represents a Trip Curve Characteristic. The LTM R controller stores the selected setting in its Thermal Overload Mode parameter. Only one setting can be activated at a time. See the topics that immediately follow, for information on the operation and configuration of each setting.

This function applies to both single-phase and 3-phase motors.

Parameter Settings

The Thermal Overload function has the following configurable parameter settings, which apply to every trip current characteristic:

Parameters	Setting range	Factory setting
Mode	• Inverse thermal • Definite time	Inverse thermal
Fault enable	Enable/Disable	Enable
Warning enable	Enable/Disable	Enable
Motor auxiliary fan cooled	Enable/Disable	Disable

Thermal Overload - Inverse Thermal

Description

When you set the Thermal Overload Mode parameter to **Inverse Thermal** and select a motor trip class, the LTM R controller monitors the motor's utilized thermal capacity and signals:

- a warning when utilized thermal capacity exceeds a configured warning threshold.
- a fault when utilized thermal capacity continuously exceeds a calculated fault threshold, based on the Motor Trip Class setting.

⚠ CAUTION

RISK OF MOTOR OVERHEATING

The Motor Trip Class parameter must be set to the thermal heating characteristics of the motor. Refer to the motor manufacturer's instructions before setting this parameter.

Failure to follow this instruction can result in injury or equipment damage.

There is no time delay for the thermal overload warning.

When inverse thermal fault mode is selected, the LTM R controller estimates the:

- Time to Trip: the time until a fault will occur.
- Minimum Wait Time: after a fault has occurred, the time until the LTM R controller will be automatically reset.

For more information about Time to Trip, see *p. 112*, and for more information about Minimum Wait Time see *p. 114*.

The LTM R controller calculates the Thermal Capacity Level in all operating states. When power to the LTM R controller is lost, the LTM R controller retains the last measurements of the motor's thermal state for a period of 30 minutes, permitting it to re-calculate the motor's thermal state when power is re-applied.

Fault and warning monitoring can be separately enabled and disabled.

This function applies to both single-phase and 3-phase motors.

Reset for Emergency Restart

You can use the Clear Thermal Capacity Level Command—issued from the PLC or an HMI—to re-start an overloaded motor in an emergency situation. This command resets the thermal capacity utilization value to 0 and bypasses the cooling period required by the thermal model before the motor can be restarted.

⚠ WARNING

LOSS OF MOTOR PROTECTION

Clearing the thermal capacity level inhibits thermal protection and can cause equipment overheating and fire. Continued operation with inhibited thermal protection should be limited to applications where immediate restart is vital.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

The Clear Thermal Capacity Level Command will not reset the fault response. Instead:

- only an action external to the LTM R controller (for example, a reduction in the motor load) can clear the fault condition
- only a reset command, from the valid reset means configured in the Fault Reset Mode parameter, will reset the fault response.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

A reset command may re-start the motor if the LTM R controller is used in a 2-wire control circuit.

Equipment operation must conform to local and national safety regulations and codes.

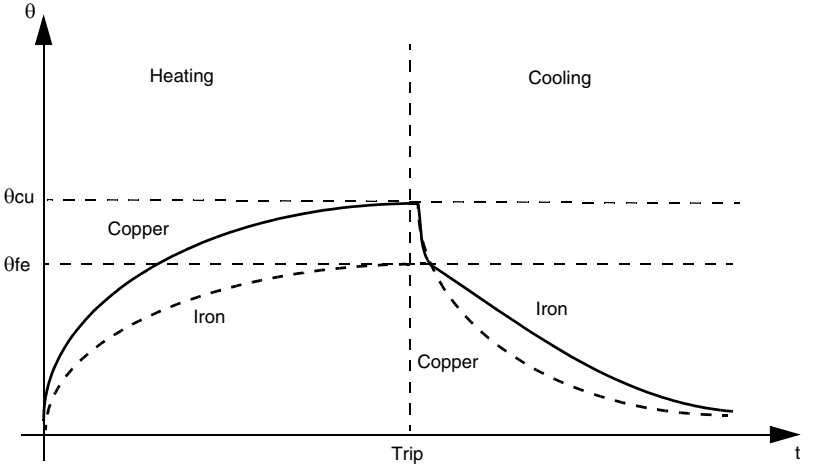
Failure to follow this instruction can result in death, serious injury, or equipment damage.

Operation

The thermal overload inverse thermal protection function is based on a thermal model of the motor that combines two thermal images:

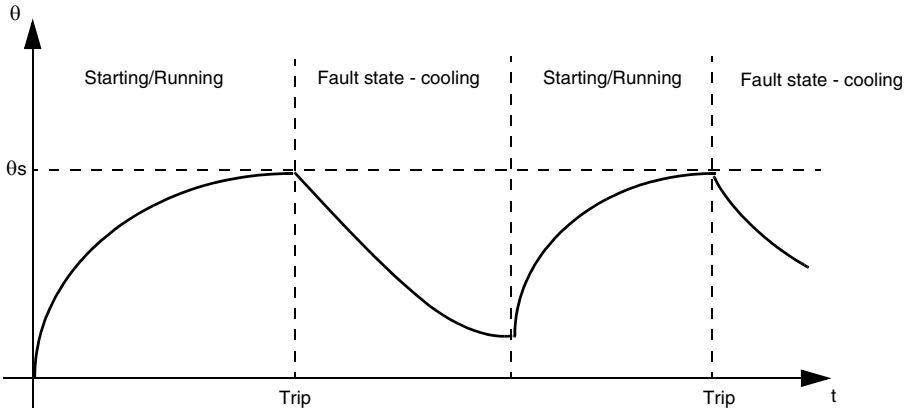
- a copper-based image representing the thermal state of the stator and rotor windings, and
- an iron-based image representing the thermal state of the motor frame

Using measured current and the input motor trip class setting, the LTM R controller considers only the highest thermal state—iron or copper—when calculating thermal capacity utilized by the motor, as described below:



θ thermal value
θ**fe** iron tripping threshold
θ**cu** copper tripping threshold
t Time

When inverse thermal fault mode is selected, the Thermal Capacity Level parameter–indicating utilized thermal capacity due to load current–is incremented during both start and run states. When the LTM R controller detects that the thermal capacity level (q) exceeds the fault threshold (qs), it triggers a thermal overload fault, as described below:



Fault and warning monitoring can be separately enabled and disabled. The LTM R controller will clear a thermal overload fault or warning when the utilized thermal capacity falls below 95% of the threshold.

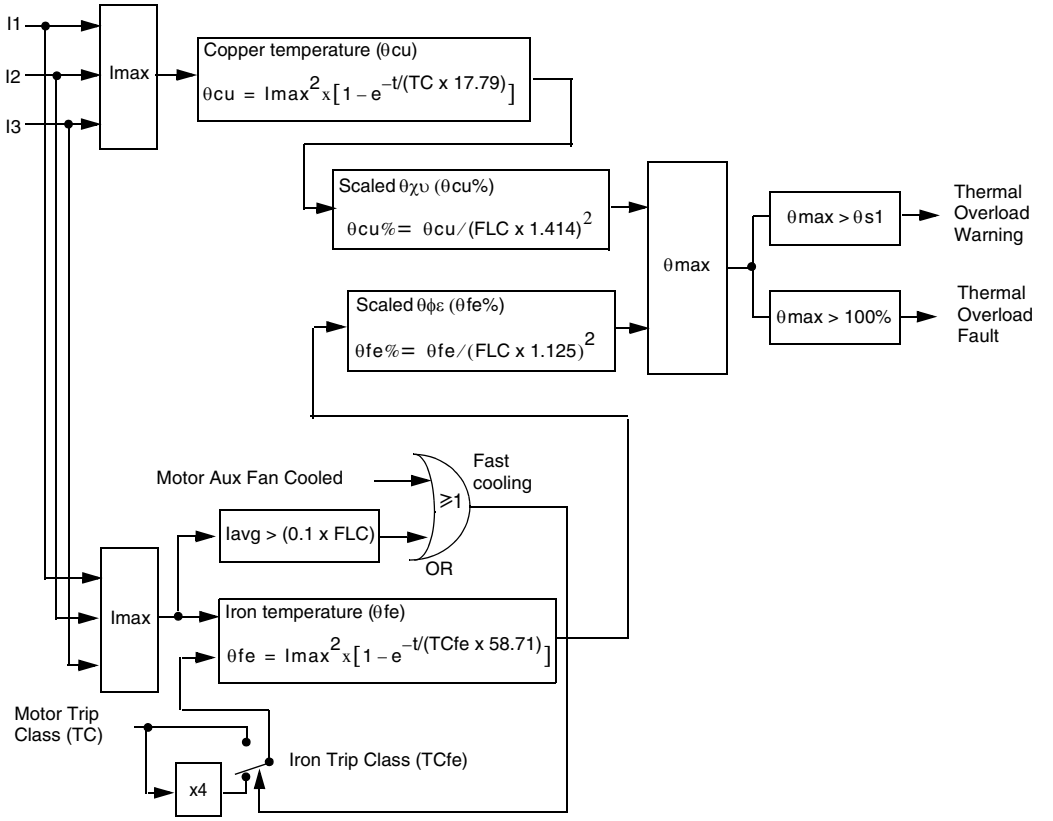
Functional Characteristics

The Thermal Overload inverse thermal functions include the following features:

- 1 motor trip class setting:
  - Motor Trip Class
- 4 configurable thresholds:
  - Motor Full Load Current Ratio (FLC1)
  - Motor High Speed Full Load Current Ratio (FLC2)
  - Thermal Overload Warning Threshold
  - Thermal Overload Fault Reset Threshold
- 2 function outputs:
  - Thermal Overload Warning
  - Thermal Overload Fault
- 2 counting statistics:
  - Thermal Overload Faults Count
  - Thermal Overload Warnings Count
- 1 setting for an external auxiliary motor cooling fan:
  - Motor Aux Fan Cooled
- 1 measure of utilized thermal capacity:
  - Thermal Capacity Level

Note: For LTM R controllers configured for 2-speed predefined operating mode, two fault thresholds are used: FLC1 and FLC2.

Block Diagram



17.79 copper trip class constant
58.71 iron trip class constant
e Euler's constant (2.71828...)
FLC Full load current parameter value (FLC1 or FLC2)
Imax Maximum phase current
t time
TC Motor Trip Class value
TCfe Iron Trip Class value
θ**cu** Copper temperature
θ**cu%** Scaled copper temperature
θ**fe** Iron temperature
θ**fe%** Scaled iron temperature
θ**s1** Thermal overload warning threshold

Parameter Settings

The thermal overload inverse thermal functions have the following configurable parameter settings:

Parameters	Setting range	Factory setting
FLC1, FLC2 (fault threshold)	• 0.4...8.0 A in increments of 0.08 A for LTMR08 • 1.35...27.0 A in increments of 0.27 A for LTMR27 • 5...100 A in increments of 1 A for LTMR100	• 0.4 A for LTMR08 • 1.35 A for LTMR27 • 5 A for LTMR100
Warning threshold	10...100% of thermal capacity	85% of thermal capacity
Motor trip class	5...30 in increments of 5	5
Fault reset timeout	50...999 in 1 s increments	120 s
Fault reset threshold	35...95% of thermal capacity	75% of thermal capacity

The thermal overload inverse thermal functions have the following non-configurable parameter settings:

Parameter	Fixed setting
Thermal overload fault threshold	100% of thermal capacity

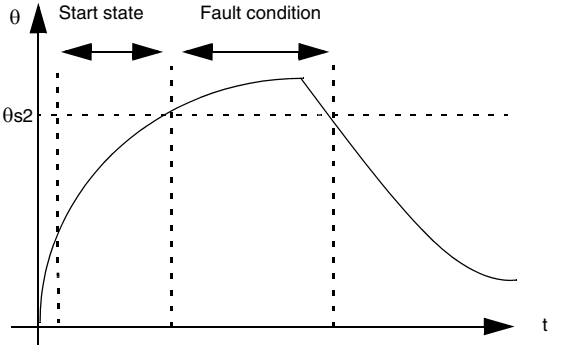
Function Characteristics

The thermal overload inverse thermal functions have the following characteristics:

Characteristics	Value
Hysteresis	95% of thermal overload warning threshold
Trip time accuracy	+/–0.1 s

Example

The following diagram describes a thermal overload inverse thermal fault:



θ Thermal capacity
θ**s2** Fault threshold (100% of thermal capacity)

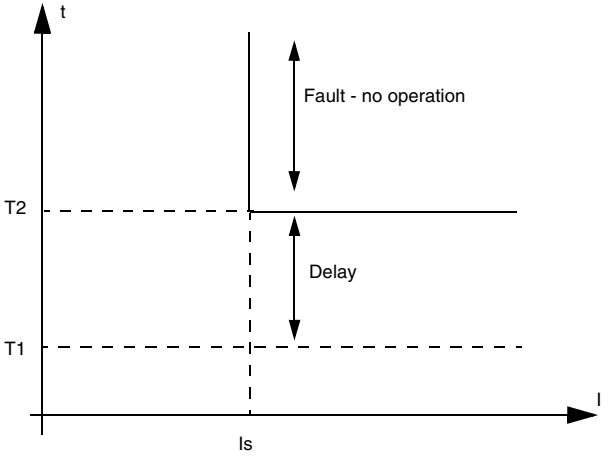
Thermal Overload - Definite Time

Description

When you set the Thermal Overload Mode parameter to **Definite Time**, the LTM R controller signals:

- a warning when measured maximum phase current exceeds a configurable threshold (OC1 or OC2).
- a fault when the maximum phase current continuously exceeds the same threshold (OC1 or OC2) for a set time delay.

The thermal overload definite time fault includes a time delay of constant magnitude - following a start command - before the protection is active and a fault timeout duration, as described below:



Is Fault and warning threshold (OC1 or OC2)
T1 Start command
T2 Elapsed time delay

There is no time delay for the thermal overload definite time warning.

Fault and warning monitoring can be separately enabled and disabled.

When the LTM R controller is connected to a 2-speed motor, two thresholds are used: 1 for low speed (OC1) and 1 for high speed (OC2).

The definite time protection function is disabled following a start by a delay defined by the Long Start Fault Timeout setting. The LTM R controller, when configured for overload predefined operating mode, uses the change in state from off to on level current to begin the Start state. This delay allows the motor to draw current on startup required to overcome the inertia of the motor at rest.

Note: Configuration of this protection function requires configuration of the Long Start protection function—including the Long Start Fault Timeout parameter.

This function applies to both single-phase and 3-phase motors.

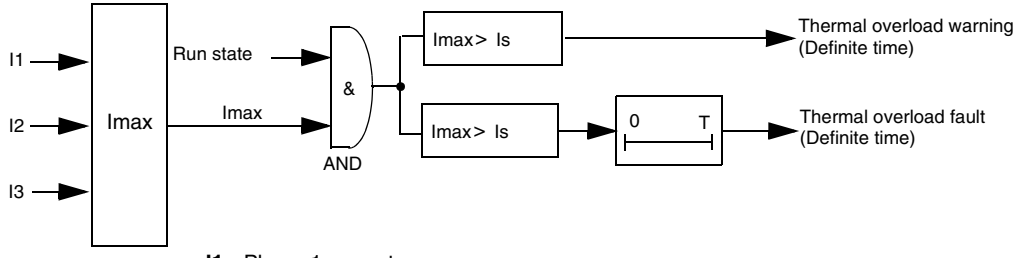
Functional Characteristics

The thermal overload definite time function includes the following features:

- 2 configurable threshold settings; one setting (OC1) is used for single speed motors, both settings are required for 2-speed motors:
  - OC1(Motor Full Load Current Ratio) or
  - OC2 (Motor High Speed Full Load Current Ratio)
- 1 time delay:
  - Overcurrent Time (O-Time, set by the Thermal Overload Fault Definite Timeout parameter)
- 2 function outputs:
  - Thermal Overload Warning
  - Thermal Overload Fault
- 2 counting statistics:
  - Thermal Overload Faults Count
  - Thermal Overload Warnings Count

Block Diagram

Thermal overload warning and fault:



I1 Phase 1 current
I2 Phase 2 current
I3 Phase 3 current
Is Fault and warning threshold (OC1 or OC2)
T Fault timeout

Parameter Settings

The definite time thermal overload function has the following configurable parameter settings:

Parameters	Setting range	Factory setting
Fault threshold: • Motor full load current ratio (OC1) - or - • Motor high speed full load current ratio (OC2)	5...100% of FLCmax, in 1% increments. Note: OC1 and OC2 settings can be set directly–in Amperes–in the Settings menu of an HMI, or in the Settings branch of PowerSuite™ software.	5% FLCmax
Thermal overload fault definite timeout ("O-Time" or over-current time)	1...300 s in 1 s increments	10 s
Thermal overload warning threshold	20–800% of FLC1 in 1 s increments	80% of FLC1
Long start fault timeout[1]	1...200 s in 1 s increments	10 s
[1] The definite time thermal overload function requires the contemporaneous use of the Long start motor protection function, both of which employ the Long start fault timeout setting.		

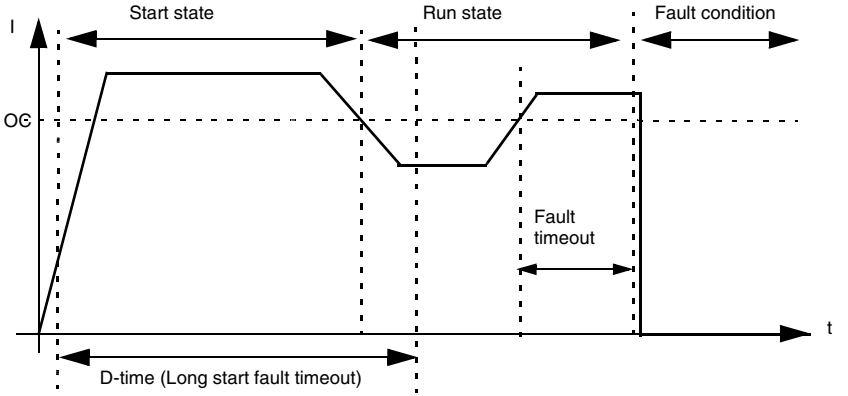
Function Characteristics

The definite time thermal overload function has the following characteristics:

Characteristics	Value
Hysteresis	95% of warning and fault thresholds
Trip time accuracy	+/–0.1 s

Example

The following diagram describes a definite time thermal overload fault:



OC Fault threshold (OC1 or OC2)

Current Phase Imbalance

Description

The current phase imbalance function signals:

- a warning when the current in any phase differs by more than a set percentage from the average current in all 3 phases.
- a fault when the current in any phase differs by more than a separately set percentage from the average current in all 3 phases for a set period of time.

⚠ CAUTION

RISK OF MOTOR OVERHEATING

The Current Phase Imbalance Fault Threshold must be properly set to protect the wiring and motor equipment from harm caused by motor overheating.

- The setting you input must conform to national and local safety regulations and codes.
- Refer to the motor manufacturer's instructions before setting this parameter.

Failure to follow this instruction can result in injury or equipment damage.

Note: Use this function to detect and guard against smaller current phase imbalances. For larger imbalances—in excess of 80% of the average current in all 3 phases—use the current phase loss motor protection function.

This function has two adjustable fault time delays:

- one applies to current imbalances occurring while the motor is in start state, and
- one applies to current imbalances occurring after startup while the motor is in run state

Both timers begin if the imbalance is detected in start state.

The function identifies the phase causing a current imbalance. If the maximum deviation from the 3 phase current average is the same for two phases, the function identifies both phases.

Fault and warning monitoring can be separately enabled and disabled.

The function applies only to 3-phase motors.

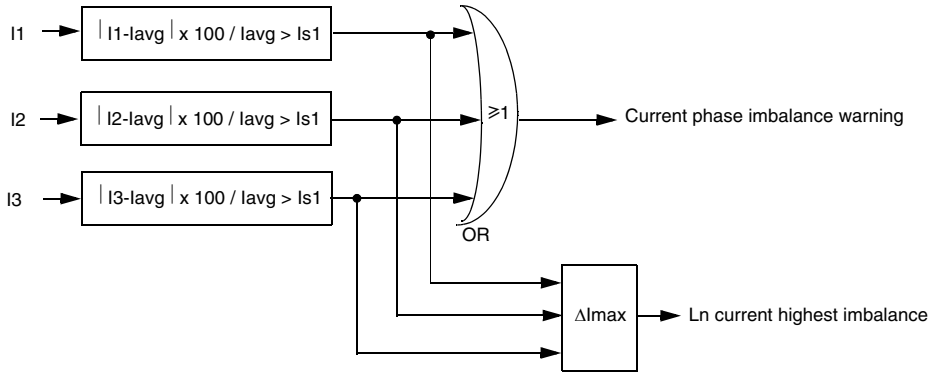
Functional Characteristics

The current phase imbalance function includes the following features:

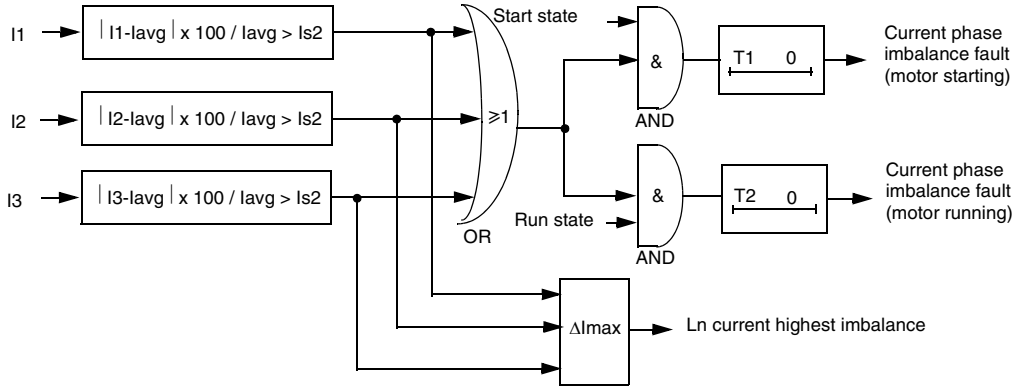
- 2 thresholds:
  - Warning Threshold
  - Fault Threshold
- 2 fault time delays:
  - Fault Timeout Starting
  - Fault Timeout Running
- 2 function outputs:
  - Current Phase Imbalance Warning
  - Current Phase Imbalance Fault
- 1 counting statistic:
  - Current Phase Imbalance Faults Count
- 3 indicators identifying the phase or phases with the highest current imbalance:
  - L1 Current Highest Imbalance
  - L2 Current Highest Imbalance
  - L3 Current Highest Imbalance

Block Diagram

Current phase imbalance warning:



Current phase imbalance fault:



I1 Phase 1 current
I2 Phase 2 current
I3 Phase 3 current
Is1 Warning threshold
Is2 Fault threshold
Ln Line number or numbers with greatest deviation from Iavg
Iavg 3 phase current average
T1 Fault timeout starting
T2 Fault timeout running

Parameter Settings

The current phase imbalance function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Enable
Fault timeout starting	0.2...20 s in 0.1 s increments	0.7 s
Fault timeout running	0.2...20 s in 0.1 s increments	5 s
Fault threshold	10...70% of the calculated imbalance in 1% increments	10%
Warning enable	Enable/Disable	Disable
Warning threshold	10...70% of the calculated imbalance in 1% increments	10%

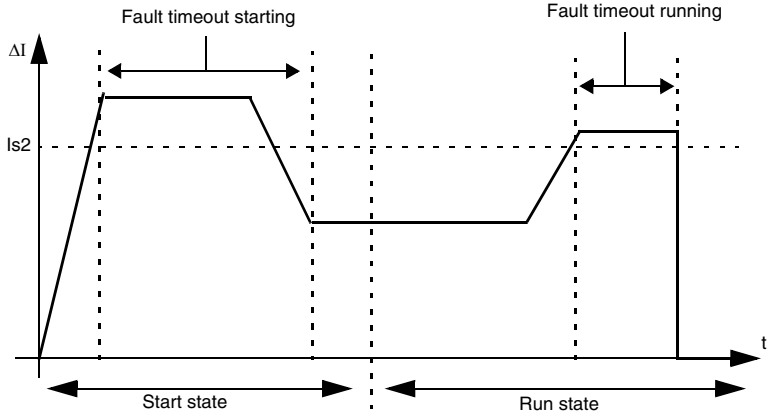
Function Characteristics

The current phase imbalance function has the following characteristics:

Characteristics	Value
Hysteresis	95% of fault or warning threshold
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the detection of a current phase imbalance occurring during run state



ΔI Percentage difference between current in any phase and the 3 phase current average
Is2 Fault threshold

Current Phase Loss

Description

The current phase loss function signals:

- a warning when the current in any phase differs by more than a 80% from the average current in all 3 phases.
- a fault when the current in any phase differs by more than 80% from the average current in all 3 phases for a set period of time.

Note: Use this function to detect and guard against large current phase imbalances— in excess of 80% of the average current in all 3 phases. For smaller current imbalances, use the current phase imbalance motor protection function.

This function has a single adjustable fault time delay, which is applied when the motor is in start state or run state.

The function identifies the phase experiencing a current loss. If the maximum deviation from the 3 current average is the same for two phases, the function identifies both phases.

Fault and warning monitoring can be separately enabled and disabled.

The function applies only to 3-phase motors.

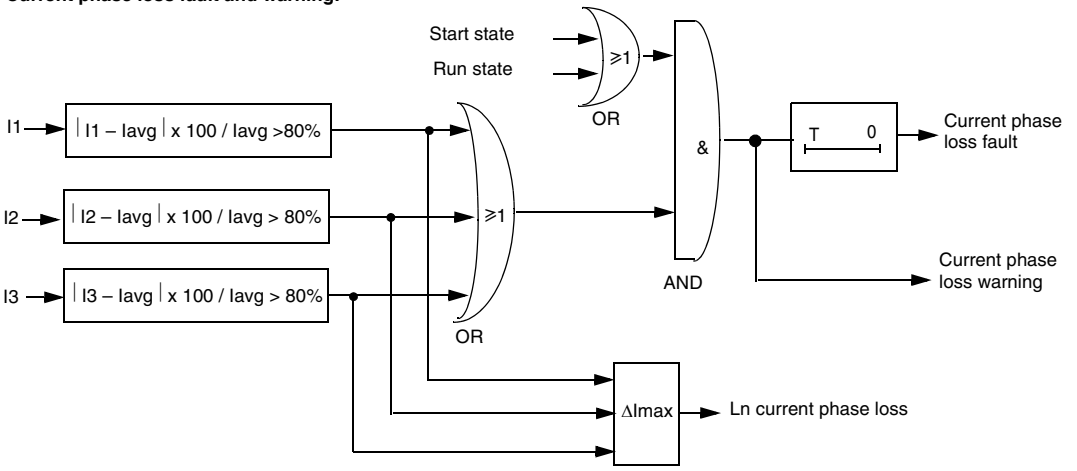
Functional Characteristics

The current phase loss function includes the following features:

- 1 fixed fault and warning threshold equal to 80% of the 3 phase average current.
- 1fault time delay:
  - Current Phase Loss Timeout
- 2 function outputs:
  - Current Phase Loss Warning
  - Current Phase Loss Fault
- 1 counting statistic:
  - Current Phase Loss Faults Count
- 3 indicators identifying the phase or phases experiencing the current loss:
  - L1 Current loss
  - L2 Current loss
  - L3 Current loss

Block Diagram

Current phase loss fault and warning:



I1 Phase 1 current
I2 Phase 2 current
I3 Phase 3 current
Ln Line current number or numbers with the greatest deviation from Iavg
Iavg 3 phase current average
T Fault timeout

Parameter Settings

The current phase loss function has the following configurable parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Enable
Timeout	0.1...30 s in 0.1 s increments	3 s
Warning enable	Enable/Disable	Enable

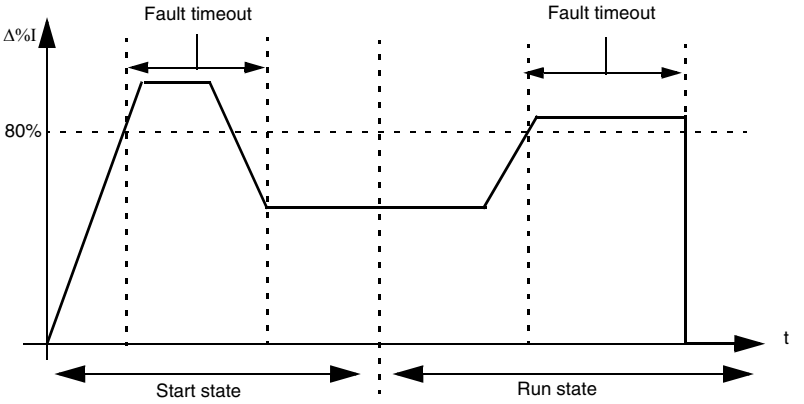
Function Characteristics

The current phase loss function has the following characteristics:

Characteristics	Value
Hysteresis	75% of the 3 phase average current
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of a current phase loss fault of a motor in run state



Δ%I Percentage difference between current in any phase and the 3 phase current average

Current Phase Reversal

Description

The current phase reversal function signals a fault when it detects that the current phases of a 3-phase motor are out of sequence with the Motor Phases Sequence parameter—ABC or ACB.

Note: When the LTM R controller is connected to an expansion module, phase reversal protection is based on voltage phase sequence before the motor starts, and on current phase sequence after the motor starts.

This function:

- is active when the motor is in start state or run state
- applies only to 3-phase motors
- has no warning and no timer.

This function can be enabled or disabled.

Functional Characteristics

The current phase reversal function adds to one counting statistic—Wiring Faults Count.

Parameter Settings

The current phase reversal function has the following configurable parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Phase sequence	• A-B-C • A-C-B	A-B-C

Function Characteristics

The current phase reversal function has the following characteristics:

Characteristic	Value
Trip time at motor startup	within 0.2 s of motor startup
Trip time accuracy	+/–0.1 s or +/–5%

Long Start

Description

The long start function detects a locked or stalled rotor in start state and signals a fault when current continuously exceeds a separately set threshold for the same period of time.

Each predefined operating mode has its own current profile, representing a successful start cycle for the motor. The LTM R controller detects a long start fault condition whenever the actual current profile—occurring after a start command—varies from the expected profile.

Fault monitoring can be separately enabled and disabled.

This function:

- applies to both single-phase and 3-phase motors
- has no warning.

Start Cycle

The configurable parameters for the Long Start protection function—Long Start Fault Threshold and Long Start Fault Timeout—are used by the LTM R controller in defining and detecting the motor's start cycle. See *p. 218*.

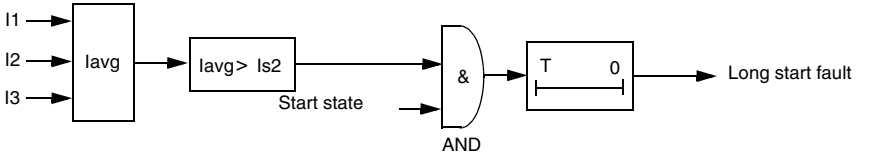
Functional Characteristics

The long start function includes the following features:

- 1 threshold:
  - Fault Threshold
- 1 fault time delay:
  - Fault Timeout
- 1 function outputs:
  - Long Start Fault
- 1 counting statistic:
  - Long Start Faults Count

Block Diagram

Long start fault:



I1 Phase 1 current
I2 Phase 2 current
I3 Phase 3 current
Is2 Fault threshold
T Fault timeout

Parameter Settings

The long start function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Enable
Fault timeout	1...200 s in 1 s increments	10 s
Fault threshold	100...800% of FLC	100% of FLC

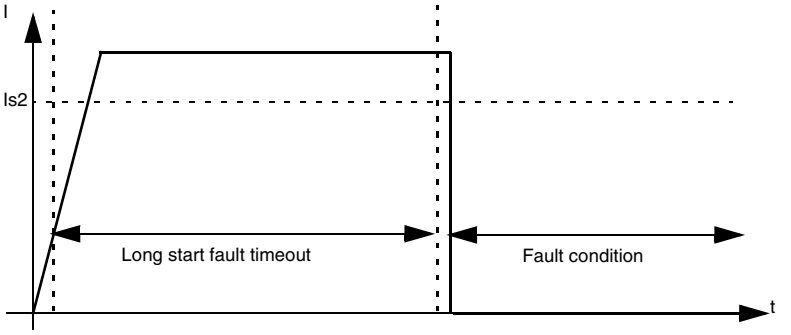
Function Characteristics

The long start function has the following characteristics:

Characteristic	Value
Hysteresis	95% of Fault threshold
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following describes the occurrence of a single threshold cross long start fault:



Is2 Long start fault threshold

Jam

Description

The jam function detects a locked rotor during run state and signals:

- a warning when current in any phase exceeds a set threshold, after the motor has reached run state.
- a fault when current in any phase continuously exceeds a separately set threshold for a specified period of time, after the motor has reached run state.

The jam function is triggered when the motor is jammed during run state and stops, or is suddenly overloaded and draws excessive current.

Fault and warning monitoring can be separately enabled and disabled.

The function applies to both single-phase and 3-phase motors.

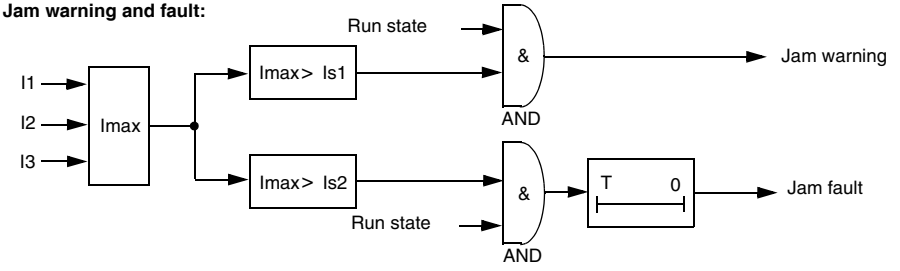
Functional Characteristics

The jam function includes the following features:

- 2 thresholds:
  - Warning Threshold
  - Fault Threshold
- 1 fault time delay:
  - Fault Timeout
- 2 function outputs:
  - Jam Warning
  - Jam Fault
- 1 counting statistic:
  - Jam Faults Count

Block Diagram

Jam warning and fault:



I1 Phase 1 current
I2 Phase 2 current
I3 Phase 3 current
Is1 Warning threshold
Is2 Fault threshold
T Fault timeout

Parameter Settings

The jam function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Enable
Fault timeout	1...30 s in 1 s increments	5 s
Fault threshold	100...800% of FLC in 1% increments	200% of FLC
Warning enable	Enable/Disable	Disable
Warning threshold	100...800% of FLC in 1% increments	200% of FLC

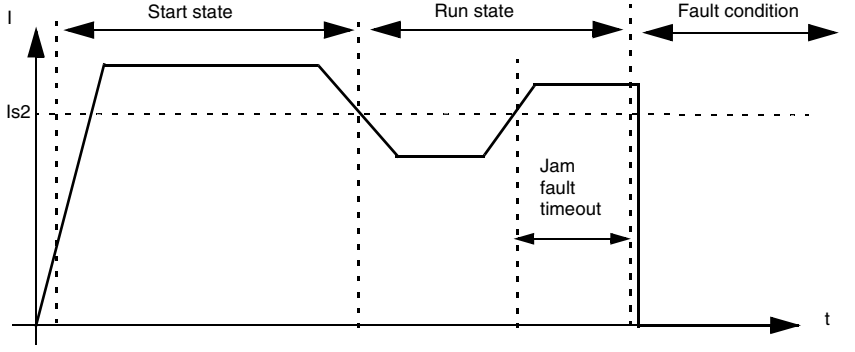
Function Characteristics

The jam function has the following characteristics:

Characteristics	Value
Hysteresis	95% of Fault threshold or Warning threshold
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of a jam fault.



Is2 Jam fault threshold

Undercurrent

Description

The undercurrent function signals:

- a warning when the 3-phase Average Current falls below a set threshold, after the motor has reached run state.
- a fault when the 3-phase Average Current falls and remains below a separately set threshold for a set period of time, after the motor has reached run state.

The undercurrent function is triggered when the motor current falls below the desired level for the driven load—for example, if a drive belt or shaft has broken, allowing the motor to run free rather than under load. This function has a single fault time delay. Fault and warning monitoring can be separately enabled and disabled.

The function applies to both single-phase and 3-phase motors.

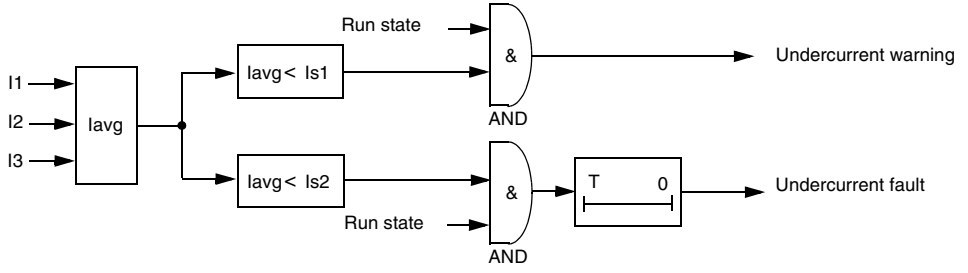
Functional Characteristics

The undercurrent function includes the following features:

- 2 thresholds:
  - Warning Threshold
  - Fault Threshold
- 1 fault time delay:
  - Fault Timeout
- 2 function outputs:
  - Undercurrent Warning
  - Undercurrent Fault
- 1 counting statistic:
  - Undercurrent Faults Count

Block Diagram

Undercurrent warning and fault:



Iavg Average current
Is1 Warning threshold
Is2 Fault threshold
T Fault timer delay

Parameter Settings

The undercurrent function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Fault timeout	1...200 s in 1 s increments	1 s
Fault threshold	30...100% of FLC in 1% increments	50% of FLC
Warning enable	Enable/Disable	Disable
Warning threshold	30...100% of FLC in 1% increments	50% of FLC

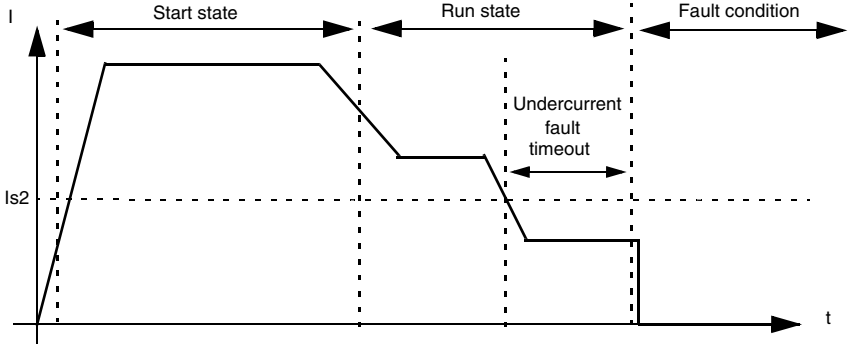
Function Characteristics

The undercurrent function has the following characteristics:

Characteristics	Value
Hysteresis	105% of Fault threshold or Warning threshold
Trip time accuracy	+/–0.1 s or +/-5%

Example

The following diagram describes the occurrence of an undercurrent fault.



Is2 Undercurrent fault threshold

Overcurrent

Description

The overcurrent function signals:

- a warning when current in a phase exceeds a set threshold, after the motor has reached run state.
- a fault when current in a phase continuously exceeds a separately set threshold for a set period of time, after the motor has reached run state.

The overcurrent function can be triggered when the equipment is overloaded or a process condition is detected causing current to increase beyond the set threshold. This function has a single fault time delay. Fault and warning monitoring can be separately enabled and disabled.

The function applies to both single-phase and 3-phase motors.

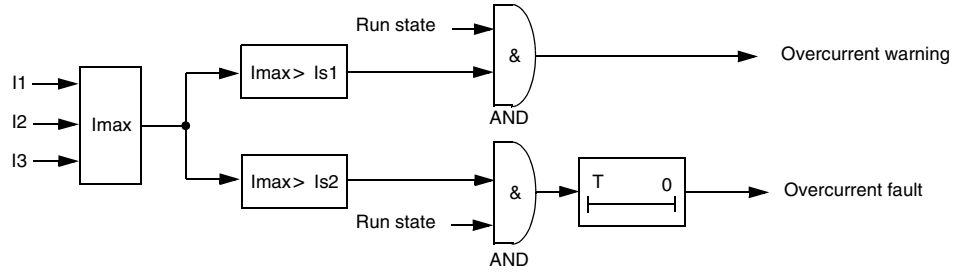
Functional Characteristics

The overcurrent function includes the following features:

- 2 thresholds:
  - Warning Threshold
  - Fault Threshold
- 1 fault time delay:
  - Fault Timeout
- 2 function outputs:
  - Overcurrent Warning
  - Overcurrent Fault
- 1 counting statistic:
  - Overcurrent Faults Count

Block Diagram

Overcurrent warning and fault:



I1 Phase 1 current
I2 Phase 2 current
I3 Phase 3 current
Is1 Warning threshold
Is2 Fault threshold
T Fault timeout

Parameter Settings

The overcurrent function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Fault timeout	1...250 s in 1 s increments	10 s
Fault threshold	20...800% of FLC in 1% increments	80% of FLC
Warning enable	Enable/Disable	Disable
Warning threshold	20...800% of FLC in 1% increments	80% of FLC

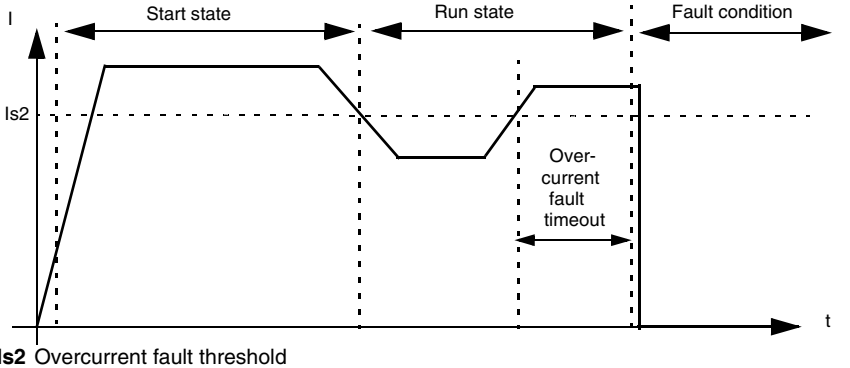
Function Characteristics

The overcurrent function has the following characteristics:

Characteristics	Value
Hysteresis	95% of Fault threshold or Warning threshold
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of an overcurrent fault.



Is2 Overcurrent fault threshold

Ground Current

Overview

The LTM R controller can be configured to detect ground current:

- internally, by summing the 3-phase current signals from the secondary of the internal current transformers.
- externally, by measuring the current delivered by the secondary of an external ground fault current transformer.

Use the Ground Current Mode parameter to select either internal or external ground fault protection. Only one of these ground current mode settings can be activated at a time.

This function applies to both single-phase and 3-phase motors.

Parameter Settings

The ground current protection function has the following configurable parameter settings, which apply to both internal and external ground current protection:

Parameters	Setting range	Factory setting
Ground current mode	• Internal • External	Internal
Fault enable	Enable/Disable	Enable
Warning enable	Enable/Disable	Enable

Internal Ground Current

Description

The internal ground current function is enabled when the Ground Current Mode parameter is set to **Internal**. When Ground Current Mode is set to **External** , the internal ground current function is disabled.

⚠ DANGER

IMPROPER FAULT DETECTION

Internal ground current function will not protect people from harm caused by ground current.
Ground fault thresholds must be set to protect the motor and related equipment.
Ground fault settings must conform to national and local safety regulations and codes.

Failure to follow this instruction will result in death or serious injury.

The internal ground current function sums the current readings from the secondary of the internal current transformers and signals:

- a warning when the summed current exceeds a set threshold.
- a fault when the summed current continuously exceeds a separately set threshold for a set period of time.

The internal ground current function has a single fault time delay.

The internal ground current function can be enabled when the motor is in ready state, start state, or run state. When the LTM R controller is operating in custom mode, this function can be configured so that it is disabled during start state, and enabled only during ready state and run state.

Fault and warning monitoring can be separately enabled and disabled.

The function applies to both single-phase and 3-phase motors.

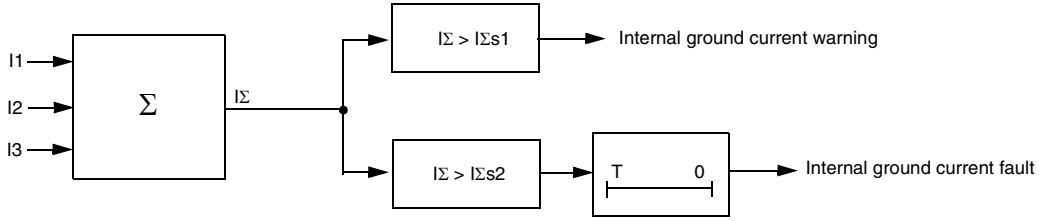
Functional Characteristics

The internal ground current function includes the following features:

- 1 measure of ground current in amperes:
  - Ground Current
- 1 measure of ground current as a % of FLC min:
  - Ground Current Ratio
- 2 thresholds:
  - Warning Threshold
  - Fault Threshold
- 1 fault time delay:
  - Fault Timeout
- 2 function outputs:
  - Internal Ground Current Warning
  - Internal Ground Current Fault
- 1 counting statistic:
  - Ground Current Faults Count

Block Diagram

Internal ground current warning and fault:



I1 Phase 1 current
I2 Phase 2 current
I3 Phase 3 current
IΣ Summed current
IΣs1 Warning threshold
IΣs2 Fault threshold
T Fault timeout

Parameter Settings

The internal ground current function has the following parameters:

Parameters	Setting range	Factory setting
Internal ground current fault timeout	0.5...25 s in 0.1 s increments	1 s
Internal ground current fault threshold	20...500% of FLCmin in 1% increments	30% of FLCmin
Internal ground current warning threshold	20...500% of FLCmin in 1% increments	30% of FLCmin

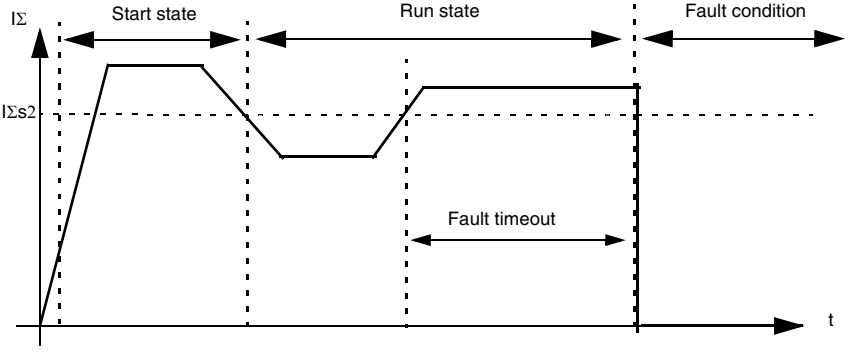
Function Characteristics

The internal ground current function has the following characteristics:

Characteristics	Value
Hysteresis	95% of Fault threshold or Warning threshold
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of an internal ground current fault occurring during run state.



IΣs2 internal ground current fault threshold

External Ground Current

Description

The external ground current function is enabled when:

- the Ground Current Mode parameter is set to **External**, and
- a current transformation ratio is set by configuring the Ground CT Primary and the Ground CT Secondary parameters.

When Ground Current Mode is set to **Internal**, the external ground current function is disabled.

⚠ DANGER

IMPROPER FAULT DETECTION

External ground current function will not protect people from harm caused by ground current.
Ground fault thresholds must be set to protect the motor and related equipment.
Ground fault settings must conform to national and local safety regulations and codes.

Failure to follow this instruction will result in death or serious injury.

The LTM R controller has 2 terminals—Z1 and Z2—that can be connected to an external ground current transformer. The external ground current function measures ground current delivered by the secondary of the external current transformer and signals:

- a warning when the delivered current exceeds a set threshold.
- a fault when the delivered current continuously exceeds a separately set threshold for a set period of time.

The external ground current function has a single fault time delay.

The external ground current function can be enabled when the motor is in ready state, start state, or run state. When the LTM R controller is operating in custom mode, this function can be configured so that it is disabled only during start state, and enabled during ready state and run state.

Fault and warning monitoring can be separately enabled and disabled.

The function applies to both single-phase and 3-phase motors.

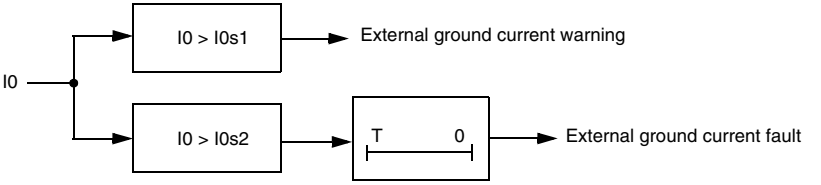
Functional Characteristics

The external ground current function includes the following features:

- 1 measure of ground current in amperes:
  - Ground Current
- 2 thresholds:
  - Warning Threshold
  - Fault Threshold
- 1 fault time delay:
  - Fault Timeout
- 2 function outputs:
  - External Ground Current Warning
  - External Ground Current Fault
- 1 counting statistic:
  - Ground Current Faults Count

Block Diagram

External ground current warning and fault:



I0 Ground current from external ground CT
I0s1 Warning threshold
I0s2 Fault threshold
T Fault timeout

Parameter Settings

The external ground current function has the following parameters:

Parameters	Setting range	Factory setting
External ground current fault timeout	0.1...25 s in 0.01 s increments	0.5 s
External ground current fault threshold	0.01...20 A in 0.01 A increments	0.01 A
External ground current warning threshold	0.01...20 A in 0.01 A increments	0.01 A

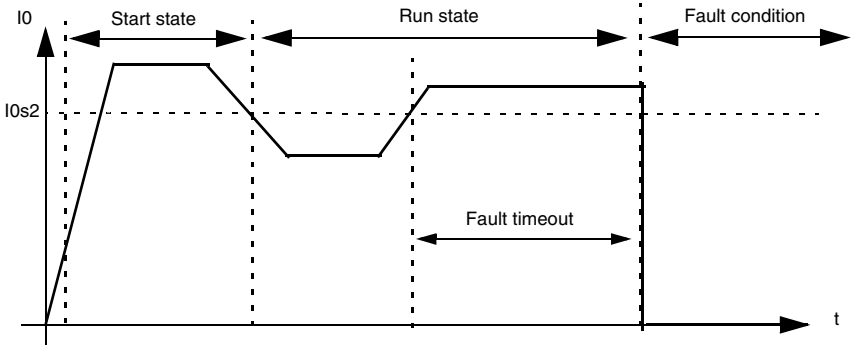
Function Characteristics

The external ground current function has the following characteristics:

Characteristics	Value
Hysteresis	95% of Fault threshold or Warning threshold
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of a external ground current fault occurring during run state.



I0s2 External ground current fault threshold

Motor Temperature Sensor

Overview

The LTM R controller has 2 terminals—T1 and T2—that can be connected to a motor temperature sensing element to provide protection for motor windings by detecting high temperature conditions that could lead to damage or degradation.

These protections are activated when the Motor Temp Sensor Type parameter is set to one of the following settings:

- PTC Binary
- PTC Analog
- NTC Analog

Only one of these motor protection sensing elements can be enabled at a time.

Note: Motor temperature sensor protection is based in ohms. PTC Binary protection thresholds are pre-set to IEC standards and are non-configurable. PTC Analog and NTC Analog protection functions may require that you scale the resistance value to the corresponding threshold level in degrees, based on the properties of the selected sensing element.

When a sensor type is changed, the LTM R controller's motor temperature sensing configuration settings revert to their default values. If a sensor type is replaced with another sensor of the same type, the setting values are retained.

This function applies to both single-phase and 3-phase motors.

Parameter Settings

The motor temperature sensor function has the following configurable parameter settings, which apply to the selected motor temp sensor type:

Parameters	Setting range	Factory setting
Sensor type	• None • PTC Binary • PTC Analog • NTC Analog	None
Fault enable	Enable/Disable	Disable
Warning enable	Enable/Disable	Disable

Motor Temperature Sensor - PTC Binary

Description

The PTC Binary motor temperature sensing function is enabled when the Motor Temp Sensor Type parameter is set to **PTC Binary** and the LTM R controller is connected to a binary positive temperature coefficient thermistor embedded in the motor.

The LTM R controller monitors the state of the temperature sensing element and signals:

- a motor temperature sensor warning when the measured resistance exceeds a fixed threshold.
- a motor temperature sensor fault when the measured resistance exceeds the same fixed threshold.

The fault and warning conditions continue until measured resistance falls below a separate fixed motor temperature sensor re-closing threshold.

Motor temperature sensing fault thresholds are factory pre-set and are not configurable. There is no fault time delay. Fault monitoring can be enabled or disabled.

The function is available for all operating states. It applies to both single-phase and 3-phase motors.

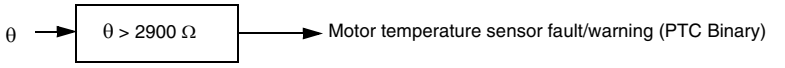
Functional Characteristics

The PTC Binary motor temperature sensor function includes the following features:

- 2 function output:
  - Motor Temp Sensor Warning
  - Motor Temp Sensor Fault
- 1 counting statistic:
  - Motor Temp Sensor Faults Count

Block Diagram

Motor temperature sensor fault/warning:



θ Temperature sensing element resistance

Parameter Settings

The PTC binary motor temperature sensor function has the following non-configurable parameter settings:

Parameter	Fixed setting	Accuracy
Fault/Warning threshold	2900 Ω	+/–2%
Fault/Warning re-closing threshold	1575 Ω	+/–2%

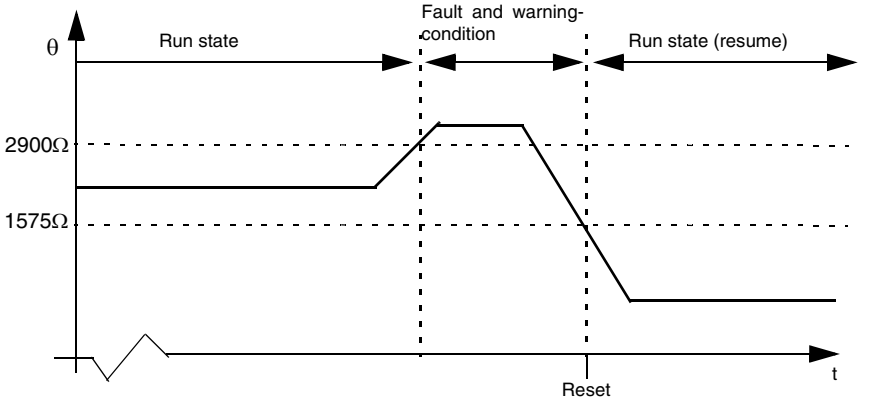
Function Characteristics

The PTC binary motor temperature sensor function has the following characteristics:

Characteristic	Value
Tripping time	0.5...0.6 s
Trip time accuracy	+/–0.1 s

Example

The following diagram describes the occurrence of a PTC binary motor temp sensor fault with an automatic reset:



2900Ω Fault threshold
1575Ω Fault re-closing threshold
Reset This marks the time after which a reset can be executed. A start command is required before run state can be resumed. In this example, auto-reset has been enabled.

Motor Temperature Sensor - PTC Analog

Description

The PTC Analog motor temperature sensing function is enabled when the Motor Temp Sensor Type parameter is set to **PTC Analog** and the LTM R controller is connected to an analog PTC thermistor embedded in the motor.

The LTM R controller monitors the state of the temperature sensing element and signals:

- a motor temperature sensor warning when the measured resistance exceeds a configurable warning threshold.
- a motor temperature sensor fault when the measured resistance exceeds a separately set fault threshold.

The fault or warning condition continues until the measured resistance falls below 95% of the fault or warning threshold.

There is no time delay to the motor temperature sensor fault or warning.

Fault and warning monitoring can be separately enabled and disabled.

The function is available for all operating states. It applies to both single-phase and 3-phase motors.

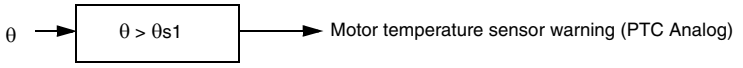
Functional Characteristics

The PTC Analog motor temperature sensor function includes the following features:

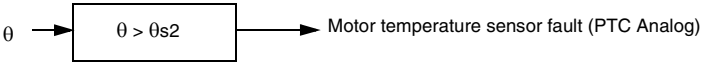
- 2 configurable thresholds:
  - Motor Temp Sensor Warning Threshold
  - Motor Temp Sensor Fault Threshold
- 2 function outputs:
  - Motor Temp Sensor Warning
  - Motor Temp Sensor Fault
- 1 counting statistic:
  - Motor Temp Sensor Faults Count

Block Diagram

Motor temperature sensor warning:



Motor temperature sensor fault:



θ Temperature sensing element resistance
θ**s1** Motor temperature sensor warning threshold
θ**s2** Motor temperature sensor fault threshold

Parameter Settings

The PTC analog motor temperature sensor function has the following configurable parameter settings:

Parameters	Setting range	Factory setting
Fault threshold	20...6500 Ω in 0.1 Ω increments	200 Ω
Warning threshold	20...6500 Ω in 0.1 Ω increments	200 Ω

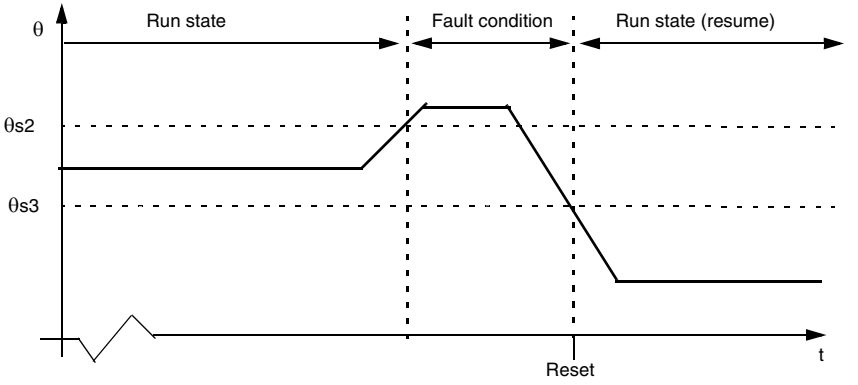
Function Characteristics

The PTC analog motor temperature sensor function has the following characteristics:

Characteristic	Value
Hysteresis	95% of Warning threshold and Fault threshold
Tripping time	0.5...0.6 s
Trip time accuracy	+/–0.1 s

Example

The following diagram describes a Motor temperature sensor PTC analog fault with automatic reset: and an active Run command:



θ**s2** Fault threshold
θ**s3** Fault re-closing threshold (95% of fault threshold)

Motor Temperature Sensor - NTC Analog

Description

The NTC Analog motor temperature sensing function is enabled when the Motor Temp Sensor Type parameter is set to **NTC Analog** and the LTM R controller is connected to an analog NTC thermistor embedded in the motor.

The LTM R controller monitors the state of the temperature sensing element and signals:

- a motor temperature sensor warning when the measured resistance falls below a configurable warning threshold.
- a motor temperature sensor fault when the measured resistance falls below a separately set fault threshold.

The fault or warning condition continues until the measured resistance exceeds 105% of the fault or warning threshold.

There is no time delay to the motor temperature sensor fault or warning.

Fault and warning monitoring can be separately enabled and disabled.

The function is available for all operating states. It applies to both single-phase and 3-phase motors.

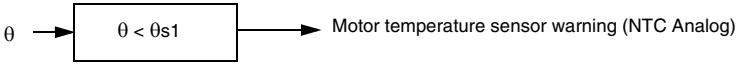
Functional Characteristics

The NTC Analog motor temperature sensor function includes the following features:

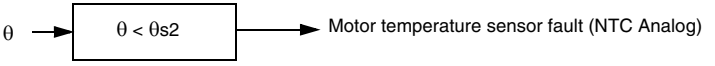
- 2 configurable thresholds:
  - Warning Threshold
  - Fault Threshold
- 2 function outputs:
  - Motor Temp Sensor Warning
  - Motor Temp Sensor Fault
- 1 counting statistic:
  - Motor Temp Sensor Faults Count

Block Diagram

Motor temperature sensor warning:



Motor temperature sensor fault:



θ Temperature sensing element resistance
θ**s1** Motor temperature sensor warning threshold
θ**s2** Motor temperature sensor fault threshold

Parameter Settings

The NTC analog motor temperature sensor function has the following configurable parameter settings:

Parameters	Setting range	Factory setting
Fault threshold	20...6500 Ω in 0.1 Ω increments	200 Ω
Warning threshold	20...6500 Ω in 0.1 Ω increments	200 Ω

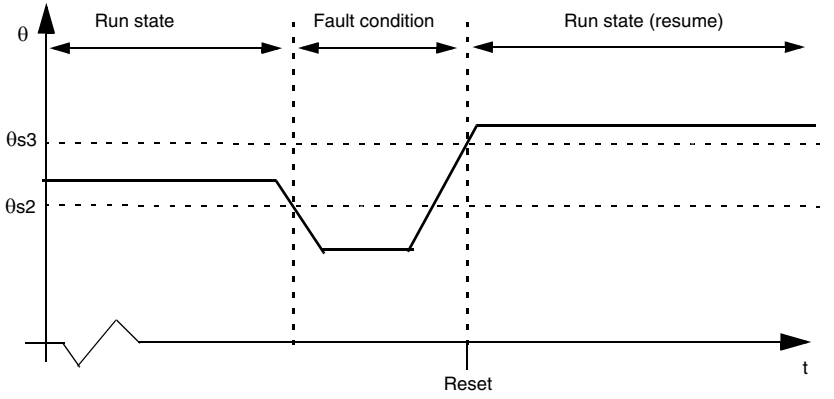
Function Characteristics

The NTC analog motor temperature sensor function has the following characteristics:

Characteristics	Value
Hysteresis	105% of Warning threshold and Fault thresholds
Tripping time	0.5...0.6 s
Trip time accuracy	+/–0.1 s

Example

The following diagram describes a Motor temperature sensor NTC analog fault with automatic reset:



θ**r2** Fault threshold
θ**r3** Fault re-closing threshold (105% of fault threshold)

Rapid Cycle Lockout

Description

The rapid cycle lockout function prevents potential harm to the motor caused by repetitive, successive inrush currents resulting from too little time between starts.

The rapid cycle lockout function provides a configurable timer, which begins its count when the LTM R controller detects On Level Current–defined as 10% of FLC. At the same time the Rapid Cycle Lockout bit is set.

If the LTM R controller detects a Run command before the rapid cycle lockout has elapsed, the:

- Rapid Cycle Lockout bit remains set
- LTM R controller ignores the Run command
- HMI (if attached) displays "WAIT"
- LTM R controller Alarm LED flashes red 5 times per second, indicating the LTM R controller has disabled motor outputs thereby preventing an undesirable condition caused by starting the motor
- LTM R controller monitors the wait time–if more than 1 timer is active, the LTM R controller reports the minimum wait time before the longest timer elapses

On power loss, the LTM R controller saves the state of the lockout timer in non-volatile memory. When the LTM R controller next powers up, the timer restarts its count and again ignores Run commands until the timer completes the timeout.

Setting the Rapid Cycle Lockout Timeout parameter to 0 disables this function.

The Rapid Cycle Lockout Timeout setting can be edited when the LTM R controller is in its normal operating state. If an edit is made while the timer is counting, the edit is effective when the timer finishes counting.

This function has no warning and no fault.

Functional Characteristics

The rapid cycle lockout function includes the following parameters:

- 1 time delay:
  - Rapid Cycle Lockout Timeout
- 1 status bit:
  - Rapid Cycle Lockout

In addition, the Rapid Cycle Lockout function:

- disables motor outputs
- causes the LTM R Alarm LED to flash 5 times per second

Parameter Settings

The rapid cycle lockout function has the following parameters:

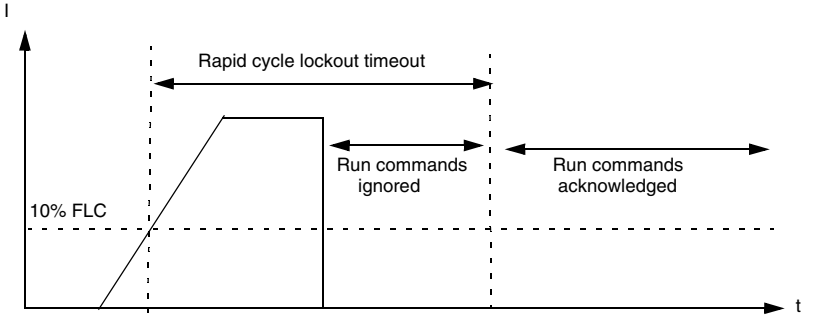
Parameters	Setting range	Factory setting
Rapid cycle lockout timeout	0...999.9 s in increments of 0.1 s	0 s

Function Characteristics

The rapid cycle lockout function has the following characteristics:

Characteristics	Value
Trip time accuracy	+/–0.1 s or +/–5%

Example



4.3 Voltage Motor Protection Functions

At a Glance

Summary

This section describes the voltage motor protection functions provided by the LTM R controller.

What's in this Section?

This section contains the following topics:

Topic	Page
Voltage Phase Imbalance	177
Voltage Phase Loss	181
Voltage Phase Reversal	184
Undervoltage	185
Overvoltage	188
Voltage Load Shedding	191

Voltage Phase Imbalance

Description

The voltage phase imbalance function signals:

- a warning when the voltage in any composed phase differs by more than a set percentage from the average voltage in all 3 phases
- a fault when the voltage in any composed phase differs by more than a separately set percentage from the average voltage in all 3 phases for a set period of time

Note: A composed phase is the combined measure of two phases: L1 + L2, L2 + L3, or L3 + L1.

This function has two adjustable fault time delays:

- one applies to voltage imbalances occurring while the motor is in start state, and
- one applies to voltage imbalances occurring while the motor is in run state, or when the long start time duration expires

Both timers begin if the imbalance is detected in start state.

Note: Use this function to detect and guard against smaller voltage phase imbalances. For larger imbalances—in excess of 40% of the average voltage in all 3 phases—use the voltage phase loss motor protection function.

This function is available in start state and run state, when the LTM R controller is connected to an expansion module.

The function identifies the phase causing a voltage imbalance. If the maximum deviation from the 3 phase voltage average is the same for two phases, the function identifies both phases.

Fault and warning monitoring can be separately enabled and disabled.

The function applies only to 3-phase motors.

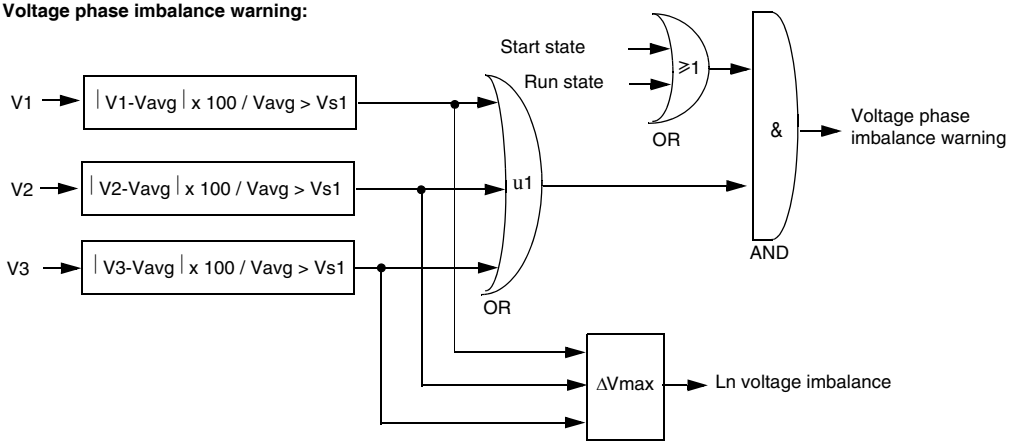
Functional Characteristics

The voltage phase imbalance function includes the following features:

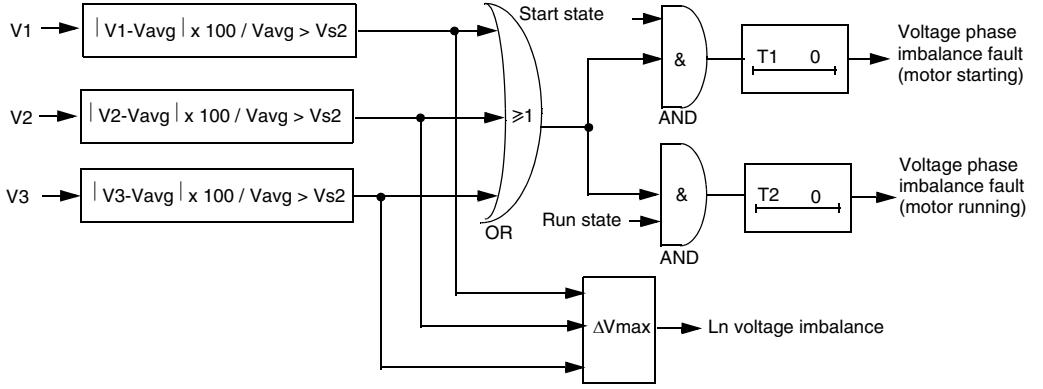
- 2 thresholds:
  - Warning Threshold
  - Fault Threshold
- 2 fault time delays:
  - Fault Timeout Starting
  - Fault Timeout Running
- 2 function outputs:
  - Voltage Phase Imbalance Warning
  - Voltage Phase Imbalance Fault
- 1 counting statistic:
  - Voltage Phase Imbalance Faults Count
- 3 indicators identifying the phase with the highest voltage imbalance:
  - L1-L2 Highest Imbalance
  - L2-L3 Highest Imbalance
  - L3-L1 Highest Imbalance

Block Diagram

Voltage phase imbalance warning:



Voltage phase imbalance fault:



V1 L1-L2 voltage
V2 L2-L3 voltage
V3 L3-L1 voltage
Ln Line number or numbers with greatest deviation from Vavg
Vs1 Warning threshold
Vs2 Fault threshold
Vavg 3 phase voltage average
T1 Fault timeout starting
T2 Fault timeout running

Parameter Settings

The voltage phase imbalance function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Fault timeout starting	0.2...20 s in 0.1 s increments	0.7 s
Fault timeout running	0.2...20 s in 0.1 s increments	2 s
Fault threshold	3...15% of the calculated imbalance in 1% increments	10%
Warning enable	Enable/Disable	Disable
Warning threshold	3...15% of the calculated imbalance in 1% increments	10%

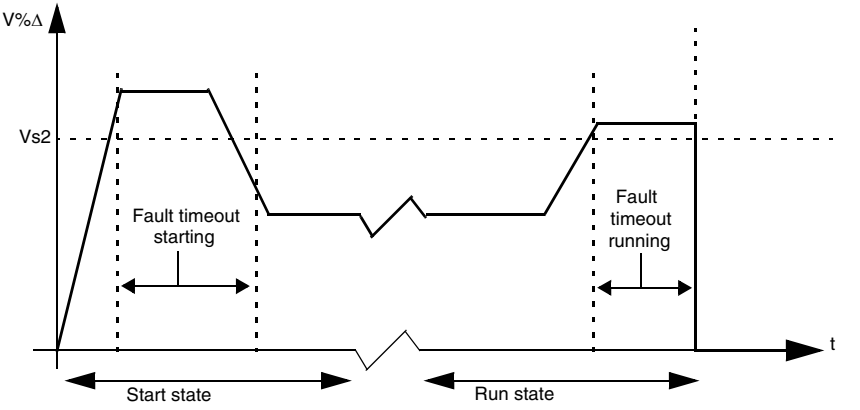
Function Characteristics

The voltage phase imbalance function has the following characteristics:

Characteristics	Value
Hysteresis	95% of Fault threshold or Warning threshold
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of a voltage phase imbalance:



V%Δ Percentage difference between voltage in any phase and the 3 phase average voltage
Vs2 Fault threshold

Voltage Phase Loss

Description

The voltage phase loss function is based on the Voltage Phase Imbalance function and signals:

- a warning when the voltage in any phase differs by more than a 40% from the average voltage in all 3 phases.
- a fault when the voltage in any phase differs by more than 40% from the average voltage in all 3 phases for a set period of time.

This function has a single adjustable fault time delay.

Note: Use this function to detect and guard against large voltage phase imbalances—in excess of 40% of the average voltage in all 3 phases. For smaller voltage imbalances, use the voltage phase imbalance motor protection function.

This function is available in ready state, when the LTM R controller is connected to an expansion module. The curent phase loss function is available during start state and run state.

The function identifies the phase experiencing a voltage loss. If the maximum deviation from the 3 phase voltage average is the same for two phases, the function identifies both phases.

Fault and warning monitoring can be separately enabled and disabled.

The function applies only to 3-phase motors.

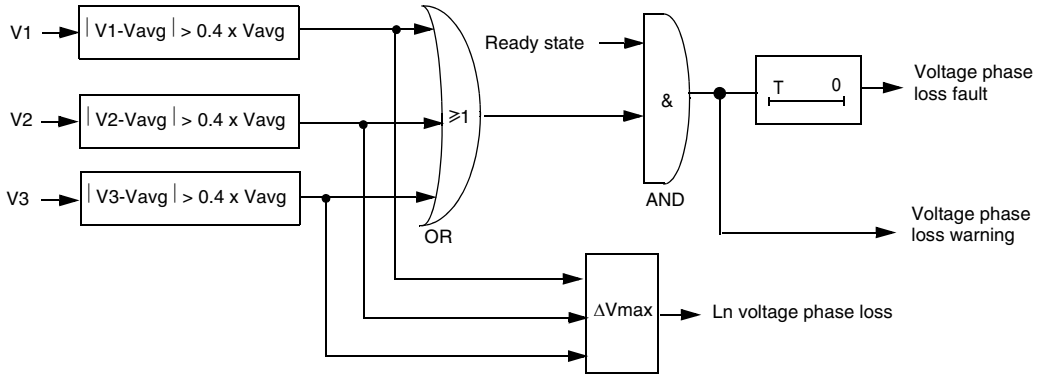
Functional Characteristics

The voltage phase loss function includes the following features:

- A fixed fault and warning threshold equal to 80% of the 3 phase average voltage.
- A single, adjustable fault time delay:
  - Voltage Phase Loss Timeout
- 2 function outputs:
  - Voltage Phase Loss Warning
  - Voltage Phase Loss Fault
- 1 counting statistic:
  - Voltage Phase Loss Faults Count
- 3 indicators identifying the phase experiencing the voltage loss:
  - L1-L2 Voltage loss
  - L2-L3 Voltage loss
  - L3-L1 Voltage loss

Block Diagram

Voltage phase loss fault and warning:



V1 L1-L2 voltage
V2 L2-L3 voltage
V3 L3-L1 voltage
Ln Line voltage number or numbers with the greatest deviation from Vavg
Vavg 3 phase average voltage
T Fault timeout

Parameter Settings

The voltage phase loss function has the following configurable parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Enable
Fault timeout	0.1...30 s in 0.1 s increments	3 s
Warning enable	Enable/Disable	Enable

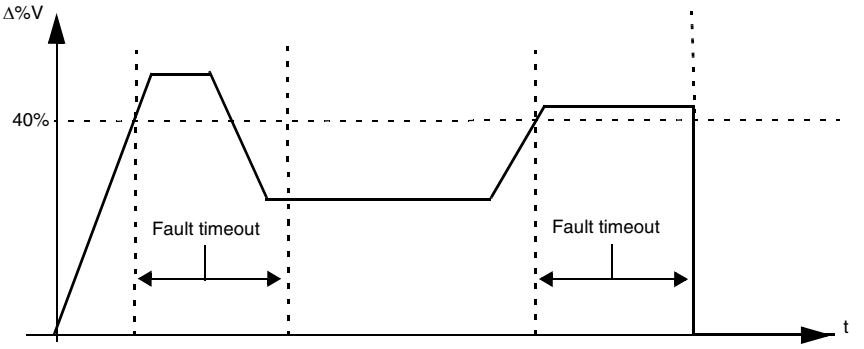
Function Characteristics

The voltage phase loss function has the following characteristics:

Characteristics	Value
Hysteresis	45% of the 3 phase average voltage
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of a voltage phase loss fault of a motor in run state:



Δ**V%** Percentage difference between voltage in any phase and the 3 phase average voltage

Voltage Phase Reversal

Description

The voltage phase reversal function signals a fault when it detects that the voltage phases of a 3-phase motor are out of sequence, usually indicating a wiring error. Use the Motor Phases Sequence parameter to configure the direction—ABC or ACB—in which the motor will turn.

This function:

- is active when the LTM R controller is connected to an expansion module
- is available when the motor is in ready state, start state and run state
- applies only to 3-phase motors
- has no warning and no timer.

This function can be enabled or disabled.

Functional Characteristics

The voltage phase reversal function adds one counting statistic—Wiring Faults Count.

Parameter Settings

The voltage phase reversal function has the following configurable parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Enable
Motor phases sequence	• A-B-C • A-C-B	A-B-C

Function Characteristics

The voltage phase reversal function has the following characteristics:

Characteristics	Value
Trip time	within 0.2 s
Trip time accuracy	+/–0.1 s

Undervoltage

Description

The undervoltage function signals:

- a warning when voltage in a phase falls below a set threshold.
- a fault when voltage in a phase falls and remains below a separately set threshold for a set period of time.

This function has a single fault time delay. Both the fault and warning thresholds are defined as a percentage of the Motor Nominal Voltage (Vnom) parameter setting.

The undervoltage function is available only in ready state and run state, when the LTM R controller is connected to an expansion module.

Fault and warning monitoring can be separately enabled and disabled.

The function applies to both single-phase and 3-phase motors.

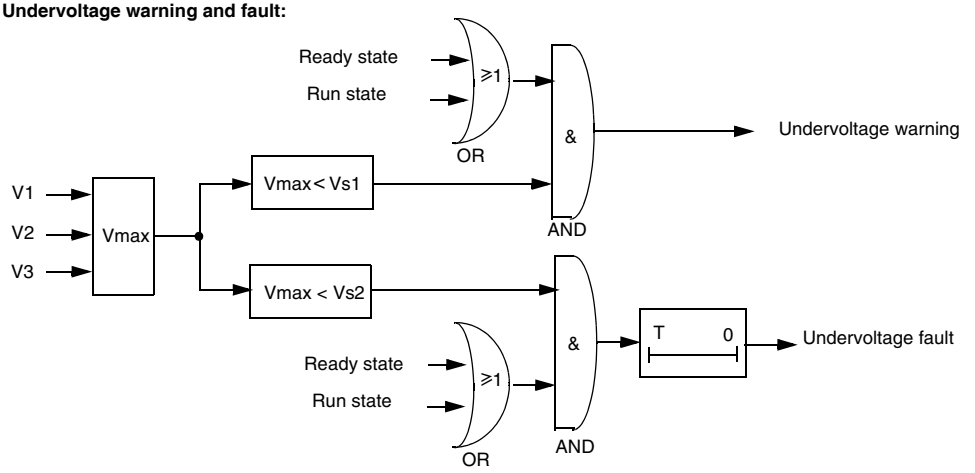
Functional Characteristics

The undervoltage function includes the following features:

- 2 thresholds:
  - Warning Threshold
  - Fault Threshold
- 1 fault time delay:
  - Fault Timeout
- 2 function outputs:
  - Undervoltage Warning
  - Undervoltage Fault
- 1 counting statistic:
  - Undervoltage Faults Count

Block Diagram

Undervoltage warning and fault:



V1 L1-L2 voltage
V2 L2-L3 voltage
V3 L3-L1 voltage
Vs1 Warning threshold
Vs2 Fault threshold
T Fault timeout

Parameter Settings

The undervoltage function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Fault timeout	0.2...25 s in 0.1 s increments	3 s
Fault threshold	70...99% of Motor nominal voltage in 1% increments	85%
Warning enable	Enable/Disable	Disable
Warning threshold	70...99% of Motor nominal voltage in 1% increments	85%

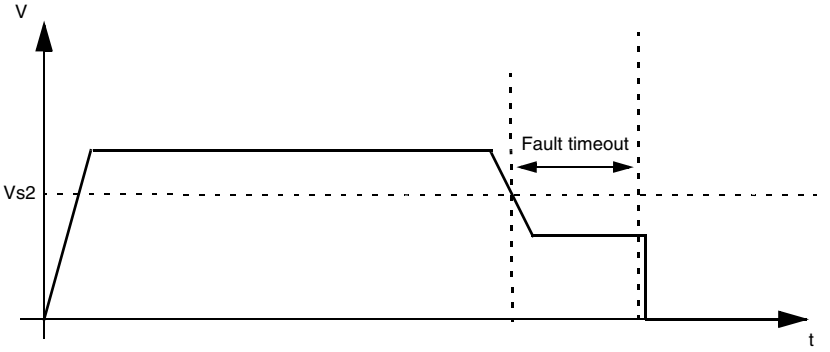
Function Characteristics

The undervoltage function has the following characteristics:

Characteristics	Value
Hysteresis	105% of Fault threshold or Warning threshold
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of a undervoltage fault.



Vs2 Undervoltage fault threshold

Overvoltage

Description

The overvoltage function signals:

- a warning when voltage in a phase exceeds a set threshold.
- a fault when voltage in a phase continuously exceeds a separately set threshold for a specified period of time.

This function has a single fault time delay. Both the fault and warning thresholds are defined as a percentage of the Motor Nominal Voltage (Vnom) parameter setting.

The overvoltage function is available in ready state and run state, when the LTM R controller is connected to an expansion module.

Fault and warning monitoring can be separately enabled and disabled.

The function applies to both single-phase and 3-phase motors.

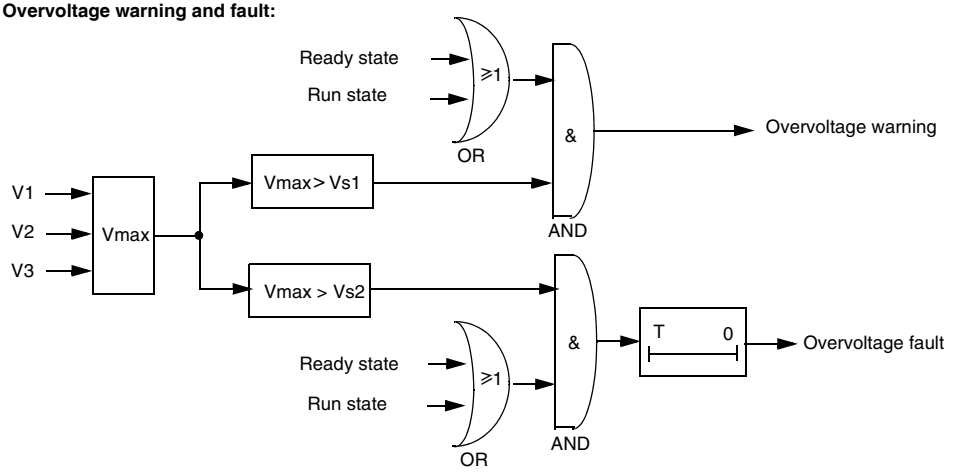
Functional Characteristics

The overvoltage function includes the following features:

- 2 thresholds:
  - Warning Threshold
  - Fault Threshold
- 1 fault time delay:
  - Fault Timeout
- 2 function outputs:
  - Overvoltage Warning
  - Overvoltage Fault
- 1 counting statistic:
  - Overvoltage Faults Count

Block Diagram

Overvoltage warning and fault:



V1 L1-L2 voltage
V2 L2-L3 voltage
V3 L3-L1 voltage
Vs1 Warning threshold
Vs2 Fault threshold
T Fault timeout

Parameter Settings

The overvoltage function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Fault timeout	0.2...25 s in 0.1 s increments	3 s
Fault threshold	101...115% of Motor nominal voltage in 1% increments	110%
Warning enable	Enable/Disable	Disable
Warning threshold	101...115% of Motor nominal voltage in 1% increments	110%

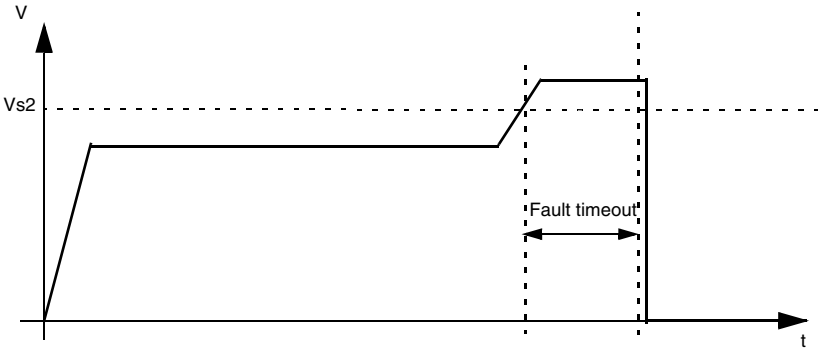
Function Characteristics

The overvoltage function has the following characteristics:

Characteristics	Value
Hysteresis	95% of Fault threshold or Warning threshold
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of an overvoltage fault.



Vs2 Overvoltage fault threshold

Voltage Load Shedding

Description

The LTM R controller provides voltage load shedding, which you can use to deactivate non-critical loads if voltage level is substantially reduced. For example, use voltage load shedding when power is transferred from a main utility supply to a backup generator system, where the backup generator system can supply power only to a limited number of critical loads.

With the voltage load shedding function enabled, the LTM R controller monitors the average phase voltage and:

- reports a load shedding condition and stops the motor when voltage falls below a configurable load shedding threshold and stays below the threshold for the duration of a configurable load shedding timer
- clears the load shedding condition when voltage rises above a configurable load shedding restart threshold and remains above the threshold for the duration of a configurable load shedding restart timer.

When the LTM R controller clears the load shedding condition:

- in 2-wire (maintained) configuration, it issues a Run command to re-start the motor
- in 3-wire (impulse) configuration, it does not automatically re-start the motor.

If your application includes another device that externally provides voltage load shedding, the LTM R controller's load shedding function should not be enabled.

All load shedding thresholds and timers can be adjusted when the LTM R controller is in its normal operating state. When a load shedding timer is counting at the time it is adjusted, the new duration time does not become effective until the timer expires.

This function is available only when your application includes an LTM E expansion module.

Functional Characteristics

The voltage load shedding function includes the following features:

- 2 thresholds:
  - Load Shedding Threshold
  - Load Shedding Restart Threshold
- 2 time delays:
  - Load Shedding Timeout
  - Load Shedding Restart Timeout
- 1 status flag
  - Load Shedding
- 1 counting statistic:
  - Load Sheddings Count

In addition, the voltage load shedding function:

- disables logic outputs O.1 and O.2
- causes the alarm LED to flash 5 times per second

Parameter Settings

The voltage load shedding function has the following parameters:

Parameters	Setting range	Factory setting
Load shedding enable	Enable/Disable	Enable
Load shedding timeout	1...9999 s in increments of 0.1 s	10 s
Load shedding threshold	68...115% of Motor nominal voltage	70%
Load shedding restart timeout	1...9999 s in increments of 0.1 minutes	10 s
Load shedding restart threshold	68...115% of Motor nominal voltage	90

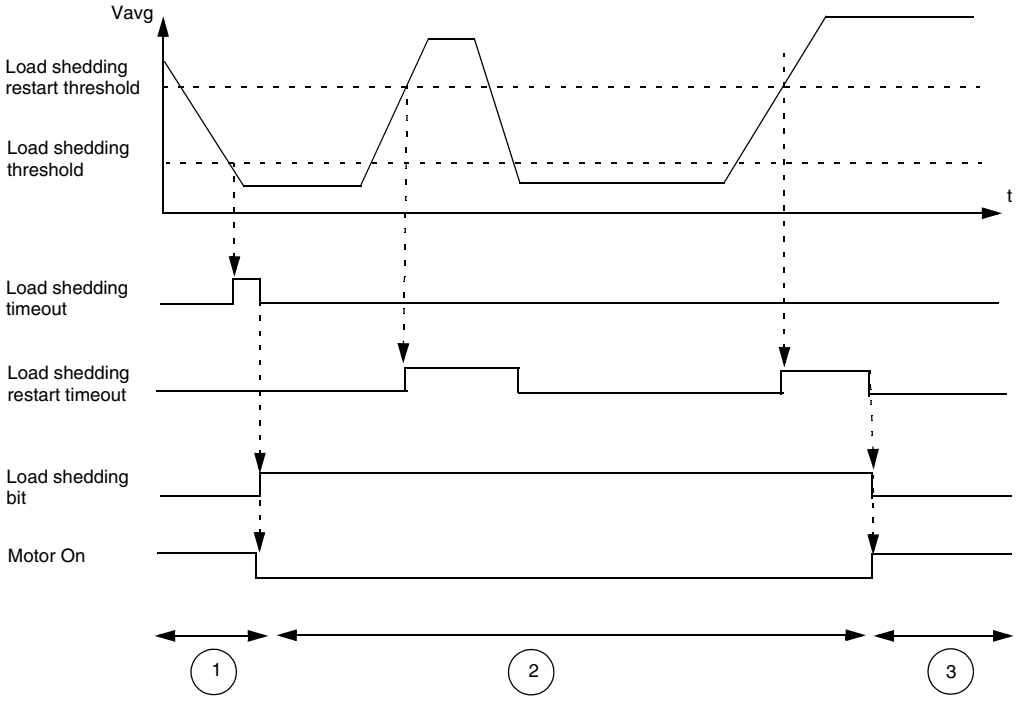
Function Characteristics

The voltage load shedding function has the following characteristics:

Characteristics	Value
Trip time accuracy	+/–0.1 s or +/–5%

Timing Sequence

The following diagram is an example of the timing sequence for the voltage load shedding function, for a 2-wire configuration with automatic restart:



1 Motor running
2 Load shed; motor stopped
3 Load shed cleared; motor auto-restart (2-wire operation)

4.4 Power Motor Protection Functions

At a Glance

Summary

This section describes the power motor protection functions provided by the LTM R controller.

What's in this Section?

This section contains the following topics:

Topic	Page
Underpower	195
Overpower	198
Under Power Factor	201
Over Power Factor	204

Underpower

Description

The underpower function signals:

- a warning when the value of active power falls below a set threshold.
- a fault when the value of active power falls and remains below a separately set threshold for a set period of time.

This function has a single fault time delay. Both the fault and warning thresholds are defined as a percentage of the Motor Nominal Power parameter setting (Pnom).

The underpower function is available only in run state, when the LTM R controller is connected to an expansion module.

Fault and warning monitoring can be separately enabled and disabled.

The function applies to both single-phase and 3-phase motors.

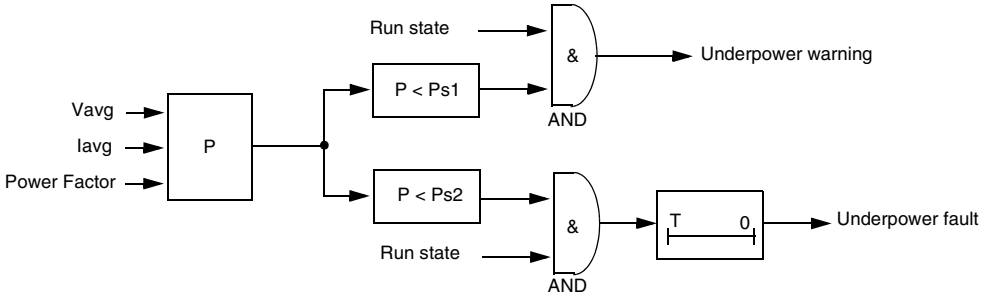
Functional Characteristics

The underpower function includes the following features:

- 2 thresholds:
  - Underpower Warning Threshold
  - Underpower Fault Threshold
- 1 fault time delay:
  - Underpower Fault Timeout
- 2 function outputs:
  - Underpower Warning
  - Underpower Fault
- 1 counting statistic:
  - Underpower Faults Count

Block Diagram

Underpower warning and fault:



Vavg Average rms voltage
Iavg Average rms current
P Power
Ps1 Warning threshold
Ps2 Fault threshold
T Fault timeout

Parameter Settings

The underpower function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Fault timeout	1...100 s in 1 s increments	60 s
Fault threshold	20...800% of Motor nominal power in 1% increments	20%
Warning enable	Enable/Disable	Disable
Warning threshold	20...800% of Motor nominal power in 1% increments	30%

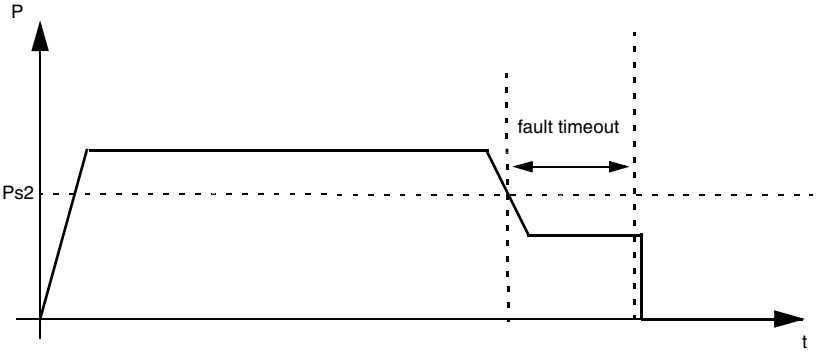
Function Characteristics

The underpower function has the following characteristics:

Characteristics	Value
Hysteresis	105% of Fault threshold or Warning threshold
Accuracy	+/–5%

Example

The following diagram describes the occurrence of an underpower fault.



Ps2 Underpower fault threshold

Overpower

Description

The overpower function signals:

- a warning when the value of active power exceeds a set threshold.
- a fault when the value of active power exceeds a separately set threshold and remains above that threshold for a set period of time.

This function has a single fault time delay. Both the fault and warning thresholds are defined as a percentage of the Motor Nominal Power parameter setting (Pnom).

The overpower function is available only in run state, when the LTM R controller is connected to an expansion module.

Fault and warning monitoring can be separately enabled and disabled.

The function applies to both single-phase and 3-phase motors.

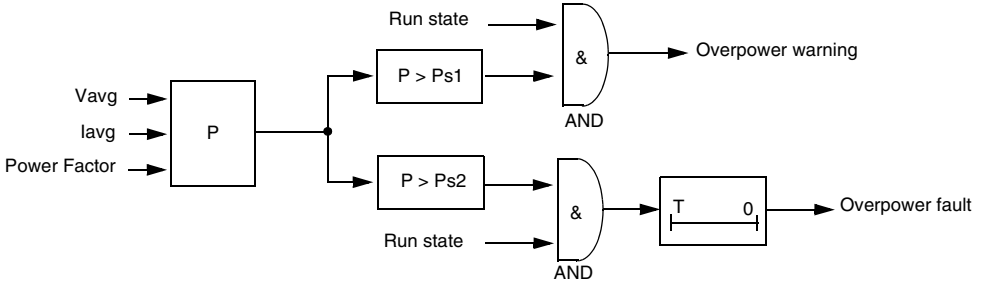
Functional Characteristics

The overpower function includes the following features:

- 2 thresholds:
  - Overpower Warning Threshold
  - Overpower Fault Threshold
- 1 fault time delay:
  - Overpower Fault Timeout
- 2 function outputs:
  - Overpower Warning
  - Overpower Fault
- 1 counting statistic:
  - Overpower Faults Count

Block Diagram

Overpower warning and fault:



Vavg Average rms voltage
Iavg Average rms current
P Power
Ps1 Warning threshold
Ps2 Fault threshold
T Fault timeout

Parameter Settings

The overpower function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Fault timeout	1...100 s in 1 s increments	60 s
Fault threshold	20...800% of Motor nominal power in 1% increments	150%
Warning enable	Enable/Disable	Disable
Warning threshold	20...800% of Motor nominal power in 1% increments	150%

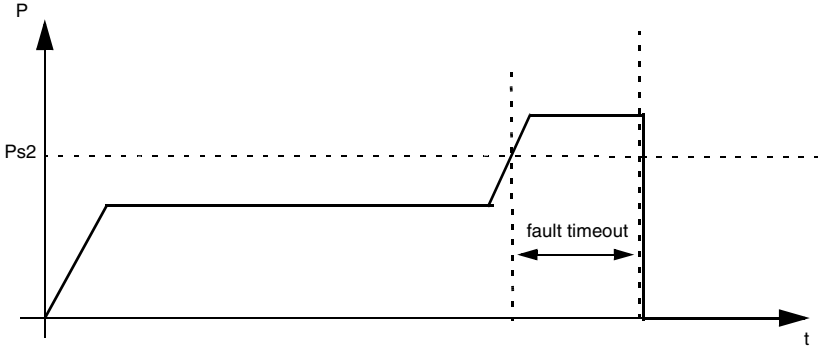
Function Characteristics

The overpower function has the following characteristics:

Characteristics	Value
Hysteresis	95% of Fault threshold or Warning threshold
Accuracy	+/–5%

Example

The following diagram describes the occurrence of an overpower fault.



Ps2 Overpower fault threshold

Under Power Factor

Description

The under power factor protection function monitors the value of the power factor and signals:

- a warning when the value of the power factor falls below a set threshold.
- a fault when the value of the power factor falls below a separately set threshold and remains below that threshold for a set period of time.

This function has a single fault time delay.

The under power factor protection function is available only in run state, when the LTM R controller is connected to an expansion module.

Fault and warning monitoring can be separately enabled and disabled.

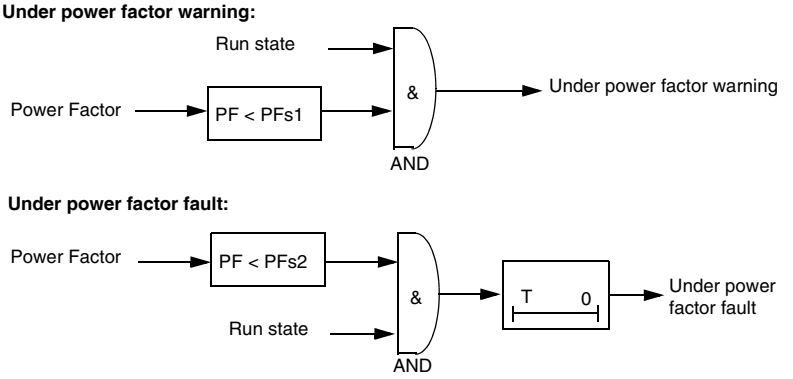
The function applies to both single-phase and 3-phase motors.

Functional Characteristics

The under power factor function includes the following features:

- 2 thresholds:
  - Under Power Factor Warning Threshold
  - Under Power Factor Fault Threshold
- 1 fault time delay:
  - Under Power Factor Fault Timeout
- 2 function outputs:
  - Under Power Factor Warning
  - Under Power Factor Fault
- 1 counting statistic:
  - Under Power Factor Faults Count

Block Diagram



PFs1 Under power factor warning threshold
PFs2 Under power factor fault threshold
T Under power factor fault timeout

Parameter Settings

The under power factor function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Fault timeout	1...25 s in 0.1 s increments	10 s
Fault threshold	0...1 x Power factor in 0.01 increments	0.60
Warning enable	Enable/Disable	Disable
Warning threshold	0...1 x Power factor in 0.01 increments	0.60

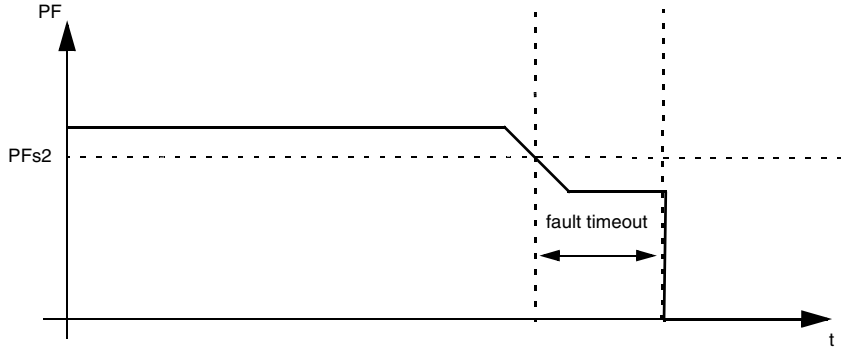
Function Characteristics

The under power factor function has the following characteristics:

Characteristics	Value
Hysteresis	105% of Fault threshold or Warning threshold
Accuracy	+/–2° or +/–3% (for Power Factors > 0.6)
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of an under power factor fault.



UPFs2 under power factor fault threshold

Over Power Factor

Description

The over power factor protection function monitors the value of the power factor and signals:

- a warning when the value of the power factor exceeds a set threshold.
- a fault when the value of the power factor exceeds a separately set threshold and remains above that threshold for a set period of time.

This function has a single fault time delay.

The over power factor protection function is available only in run state, when the LTM R controller is connected to an expansion module.

Fault and warning monitoring can be separately enabled and disabled.

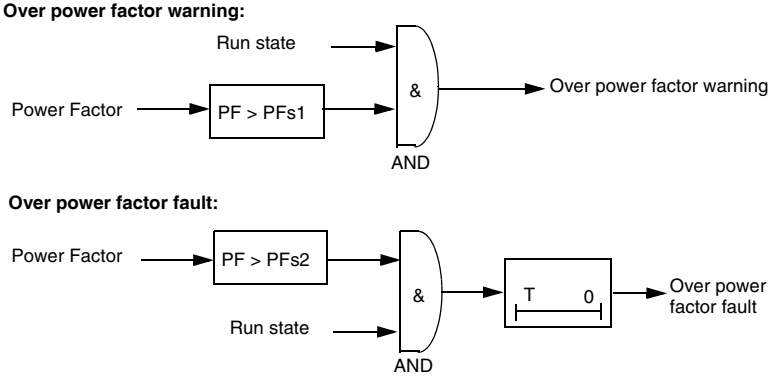
The function applies to both single-phase and 3-phase motors.

Functional Characteristics

The over power factor function includes the following features:

- 2 thresholds:
  - Over Power Factor Warning Threshold
  - Over Power Factor Fault Threshold
- 1 fault time delay:
  - Over Power Factor Fault Timeout
- 2 function outputs:
  - Over Power Factor Warning
  - Over Power Factor Fault
- 1 counting statistic:
  - Over Power Factor Faults Count

Block Diagram



PFs1 Over power factor warning threshold
PFs2 Over power factor fault threshold
T Over power factor fault timeout

Parameter Settings

The over power factor function has the following parameters:

Parameters	Setting range	Factory setting
Fault enable	Enable/Disable	Disable
Fault timeout	1...25 s in 0.1 s increments	10 s
Fault threshold	0...1 x Power factor in 0.01 increments	0.90
Warning enable	Enable/Disable	Disable
Warning threshold	0...1 x Power factor in 0.01 increments	0.90

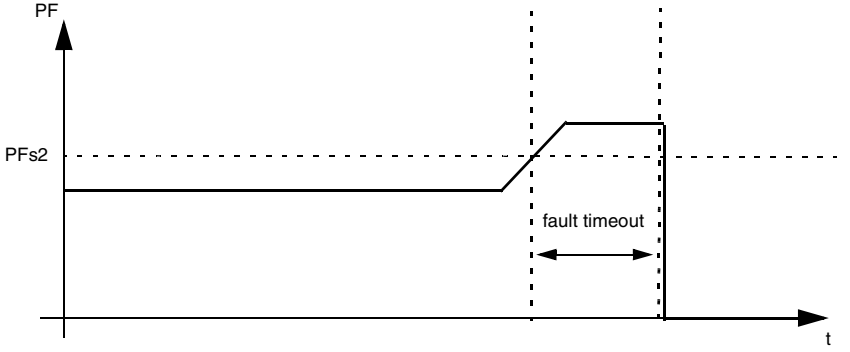
Function Characteristics

The over power factor function has the following characteristics:

Characteristics	Value
Hysteresis	95% of Fault threshold or Warning threshold
Accuracy	+/–2° or +/–3% (for Power Factors > 0.6)
Trip time accuracy	+/–0.1 s or +/–5%

Example

The following diagram describes the occurrence of an over power factor fault.



PFs2 over power factor fault threshold

Motor Control Functions

5

At a Glance

Overview

Your selection of motor operating mode serves as the primary control function for the LTM R controller. Select the combination of operating mode and control wiring option required to start, stop or monitor the state of the motor that the LTM R controller protects.

The topics in this chapter describe the LTM R controller's:

- operating states, listed below, which determine the objectives of the motor control function:
  - energized or de-energized
  - configured or not configured
  - ready to start a motor
  - starting a motor
  - running or not running a motor
  - warning response
  - fault response
- operating modes:
  - select from 1 of 10 predefined control programs
  - the selected control program monitors inputs, executes commands, and directs outputs to transition between states according to the specific needs of common motor starter applications and control sources
  - control mode selection, which directs the LTM R controller to respond to commands that originate from:
    - local terminal strip inputs via hard-wired input devices
    - local HMI commands via the HMI port
    - remote commands from the network via the network port

  This chapter also introduces custom operating mode, which you can use to either tailor a predefined control program or create a new program to meet the needs of your specific application.

- fault reset mode, which directs the control program to allow fault resets by a person, a master network controller, or the LTM R control program–depending upon the type of fault and the authorized control source. Fault reset modes include:
  - manual reset: allows resets by a person using a local reset means
  - remote reset: adds the ability to reset via commands from the remote master network controller via the LTM R controller's network port
  - automatic reset: adds the ability of the LTM R controller to reset faults automatically after a time delay.

What's in this Chapter?

This chapter contains the following sections:

Section	Topic	Page
5.1	Control Modes and Operating States	209
5.2	Operating Modes	222
5.3	Fault Management	253

5.1 Control Modes and Operating States

At a Glance

Summary

This section describes:

- how to configure control of the LTM R controller outputs, and
- the LTM R controller's operating states, including:
  - how the LTM R controller transitions between operating states during startup, and
  - the motor protection functions provided by the LTM R controller in each operating state

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program, install, alter and apply this product. Follow all local and national safety codes and standards.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

What's in this Section?

This section contains the following topics:

Topic	Page
Control Modes	210
Operating States	214
Start Cycle	218

Control Modes

Overview

The control mode determines which control sources command the LTM R controller outputs. Control modes include:

Control Mode	LTM R controller outputs are commanded by:
Local terminal strip	Input devices wired to the input terminals on the front face of the LTM R controller
Local HMI	An HMI device connected to the LTM R controller's Local HMI port
Network	A network PLC connected to the controller network port

Control Mode Selection

Control mode is determined by the combination of the:

- state of logic input I.6, and
- Control Local Channel Setting parameter.

When logic input I.6 is:	And Control Local Channel Setting is:	Control Mode is:
inactive	Local terminal strip	Local terminal strip
	Local HMI	Local HMI
active	(Not applicable)	Network

Note: Regardless of the selected control mode, the LTM R controller will respond to Stop commands from any local control source.

When logic input I.6 is inactive, the default control mode is Local Terminal Strip.

For a predefined operating mode, only one control source may be enabled to direct the outputs. You can use the custom logic editor to add one or more additional control sources.

Local Terminal Strip

In Local Terminal Strip control mode, the LTM R controller commands its outputs according to the state of its inputs. This is the default control mode setting when logic input I.6 is inactive.

The following conditions apply to Local Terminal Strip control mode:

- Any terminal inputs assigned to start and stop commands control the outputs according to the motor operating mode.
- When a logic input is active, it sets a bit in the Logic Input number (1 to 6) parameter for monitoring by the PLC.
- HMI and PLC network start commands are ignored.

Local HMI

In Local HMI control mode, the LTM R controller commands its outputs in response to start and stop commands received from an HMI device connected to the Local HMI port. via theLocal HMI RJ45 connector on either the LTM R controller or the expansion module.

The following conditions apply to Local HMI control mode:

- Any HMI start and stop commands control the outputs according to the motor operating mode.
- All terminal inputs, when active, place bits into the Controller Input number (1 to 6) parameter for monitoring by the PLC.
- Remote network start commands and local terminal start commands are ignored.

Network

In Network control mode, a remote PLC sends commands to the LTM R controller through the network communication port.

The following conditions apply to Network control mode:

- Any network start and stop commands control the outputs according to the motor operating mode.
- The HMI unit can read (but not write) the LTM R controller parameters.
- All inputs, when active, place bits into the Logic Input number (1 to 6) parameter for monitoring by the PLC.

Bump and Bumpless Control Transfers

Set the Bumpless Transfer Mode parameter to enable bumpless transfer when changing the control mode; clear this parameter to enable bump transfer. The configuration setting for this parameter determines the behavior of logic outputs O.1 and O.2, as follows:

Bumpless Transfer Mode setting	LTM R controller behavior when changing control mode
Bump	Logic outputs O.1 and O.2 open (if closed) or remain open (if already open) until the next valid signal occurs. The motor stops. Note: In overload predefined operating mode, logic outputs O.1 and O.2 are user-defined. The control and power circuit combine to determine if bumping the outputs OFF will not stop the motor.
Bumpless	Logic outputs O.1 and O.2 are not affected and remain in their original position until the next valid signal occurs. If one or more outputs were active and controlling a motor prior to the transfer, then the motor will not stop as a consequence of the transfer.

⚠ CAUTION

FAILURE TO STOP AND RISK OF UNINTENDED OPERATION

LTM R controller operation cannot be stopped from the terminals when control mode is changed to Local Terminal Strip control mode if the LTM R controller is:

- operating in Overload operating mode
  - and -
- configured for Bumpless transfer of control mode
  -and -
- operated over a network using Network control mode
  -and -
- operating in Run state
  - and -
- configured for 3-wire (impulse) control.

See instructions below.

Failure to follow this instruction can result in injury or equipment damage.

Whenever control mode is changed to Local Terminal Strip control mode, operation of the LTM R controller cannot be stopped from the terminals because no terminal input is assigned to a STOP command.

If this behavior is not intended, the control mode must be changed to either Network control mode or Local HMI control mode to command a STOP. To implement this change, take one of the following precautionary steps:

- the commissioner should configure the LTM R controller for either bump transfer of control mode or 2-wire control
- the installer should provide the LTM R controller with a means of interrupting current to the contactor coil - for example, a push button station wired in series with the LTM R controller outputs
- the controls engineer should assign a terminal input to disable the Run command using Custom Configuration Mode assignments.

Fallback Transitions

The LTM R controller enters a fallback state when communication with the control source is lost, and exits the fallback state when communication is restored. The transition into and out of the fallback state is as follows:

Transition	Control source transfer
Entering the fallback state	bumpless, when the Control Direct Transition bit is on
Exiting the fallback state	determined by the settings for Bumpless Transfer Mode (bump or bumpless) and Control Direct Transition (on or off)

For a information on how to configure communications fallback parameters, see *p. 107*.

Operating States

Introduction

The LTM R controller responds to the state of the motor and provides control, monitoring and protection functions appropriate to each of the motor's operating states. A motor can have many operating states. Some operating states are persistent while others are transitional.

A motor's primary operating states are:

Operating state	Description

Ready	• The motor is stopped and is not drawing current.
	• The LTM R controller:
	  • detects no fault
	  • is not performing load shedding
	  • is not counting down the rapid cycle timer
	  • is ready to start

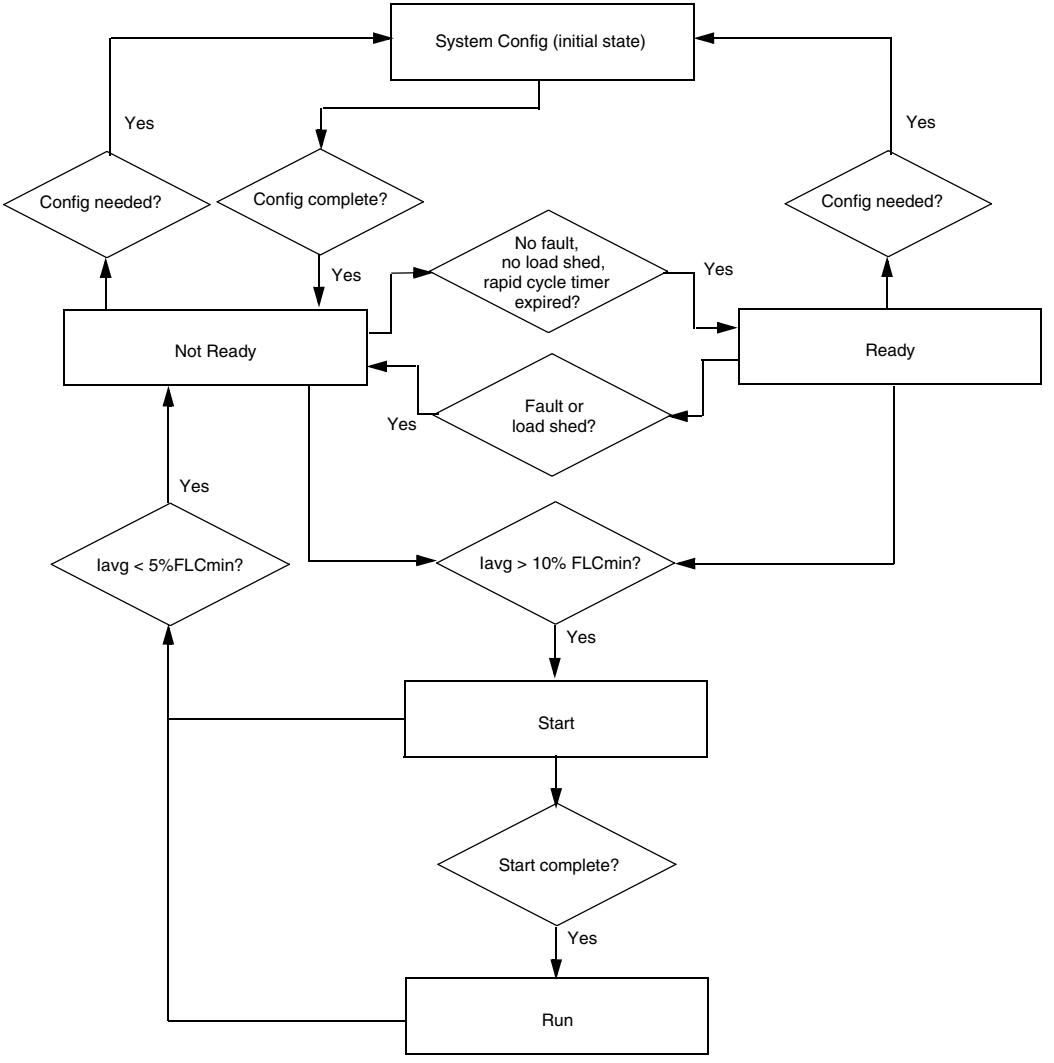
Not Ready	• The motor is stopped and is not receiving current.
	• The LTM R controller:
	  • detects a fault
	  • is performing load shedding
	  • is counting down the rapid cycle timer

Start	• The motor begins to receive current.
	• The LTM R controller:
	  • detects that current has reached the On Level Current threshold
	  • detects that current has not both crossed and re-crossed the long start fault threshold
	  • continues to count down the long start fault timer.

Run	• The motor continues to receive current. • The LTM R controller detects that current has both crossed and re-crossed the long start fault threshold before the LTM R controller fully counted down the long start fault timer.

Operating State Chart

The operating states of the LTM R controller firmware—as the motor progresses from Off to Run state—are described below. The LTM R controller verifies current in each operating state. The LTM R controller can transition to an internal fault condition from any operating state.



Protection Monitoring by Operating States

The motor operating states—and the fault and warning protections provided by the LTM R controller while the motor is in each operating state (denoted with an X)—are described below. It can transition to an internal fault condition from any operating state.

Protection Category	Monitored Fault/Warning	Operating states				
		Sys Config	Ready	Not Ready	Start	Run
Diagnostic	Run Command Check	–	X	–	–	–
	Stop Command Check	–	–	X	X	X
	Run Check Back	–	–	–	X	X
	Stop Check Back	–	–	–	X	X
Wiring / configuration errors	PTC connection	–	X	X	X	X
	CT Reversal	–	–	–	X	–
	Voltage Phase Reversal	–	X	X	X	X
	Current Phase Reversal	–	–	–	X	–
	Voltage Phase Loss	–	X	X	–	–
	Phase Configuration	–	–	–	X	–
Internal faults	Minor	X	X	X	X	X
	Major	X	X	X	X	X
Thermal resistance (Motor temperature sensor)	PTC Binary	–	X	X	X	X
	PTC Analog	–	X	X	X	X
	NTC Analog	–	X	X	X	X
Thermal overload	Definite	–	–	–	–	X
	Inverse Thermal	–	X	X	X	X
Current	Long Start	–	–	–	X	–
	Jam	–	–	–	–	X
	Current Phase Imbalance	–	–	–	X	X
	Current Phase Loss	–	–	–	X	X
	Overcurrent	–	–	–	–	X
	Undercurrent	–	–	–	–	X
	Ground Fault (Internal)	–	–	–	X	X
	Ground Fault (External)	–	–	–	X	X
Voltage	Overvoltage Level	–	X	X	–	X
	Undervoltage Level	–	X	X	–	X
	Voltage Phase Imbalance	–	–	–	X	X

X Monitored
– Not monitored

Protection Category	Monitored Fault/Warning	Operating states				
		Sys Config	Ready	Not Ready	Start	Run
Power / Power Factor	Over Power Factor Level	–	–	–	–	X
	Under Power Factor Level	–	–	–	–	X
	Overpower Level	–	–	–	–	X
	Underpower Level	–	–	–	–	X
X Monitored **– Not monitored**						

Start Cycle

Description

The start cycle is the time period allowed for the motor to reach its normal FLC level. The LTM R controller measures the start cycle in seconds, beginning when it detects On Level Current—defined as maximum phase current equal to 10% of FLC.

During the start cycle, the LTM R controller compares:

- detected current against the configurable Long Start Fault Threshold parameter, and
- elapsed start cycle time against the configurable Long Start Fault Timeout parameter.

There are 3 start cycle scenarios, each based on the number of times—0, 1or 2—maximum phase current crosses the Long Start Fault Threshold. A description of each scenario is described below.

For information on the statistics the LTM R controller retains describing motor starts, see *p. 66*. For information about the long start protection function, see *p. 149*.

Start Cycle Operating States

During the start cycle, the LTM R controller transitions through the motor's operating states as follows:

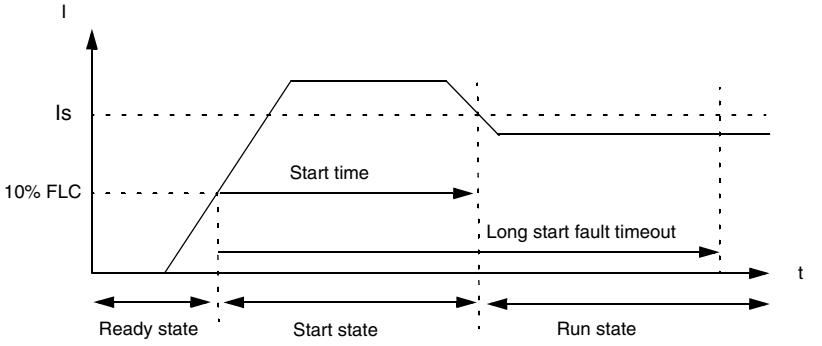
Step	Event	Operating state
1	LTM R controller receives a start command input signal.	Ready
2	The LTM R controller confirms that all startup preconditions exist (e.g. no faults, load shedding, or rapid cycle timer).	Ready
3	The LTM R controller closes the appropriate output contacts designated as terminals 13-14 or 23-24, thereby closing the control circuit of the motor starting contactors.	Ready
4	The LTM R controller detects that maximum phase current exceeds the On Level Current threshold.	Start
5	The LTM R controller detects that current rises above and then falls below the Long Start Fault Threshold before the Long Start Fault Timeout timer expires.	Run

2 Threshold Crosses

In this start cycle scenario, the start cycle executes successfully:

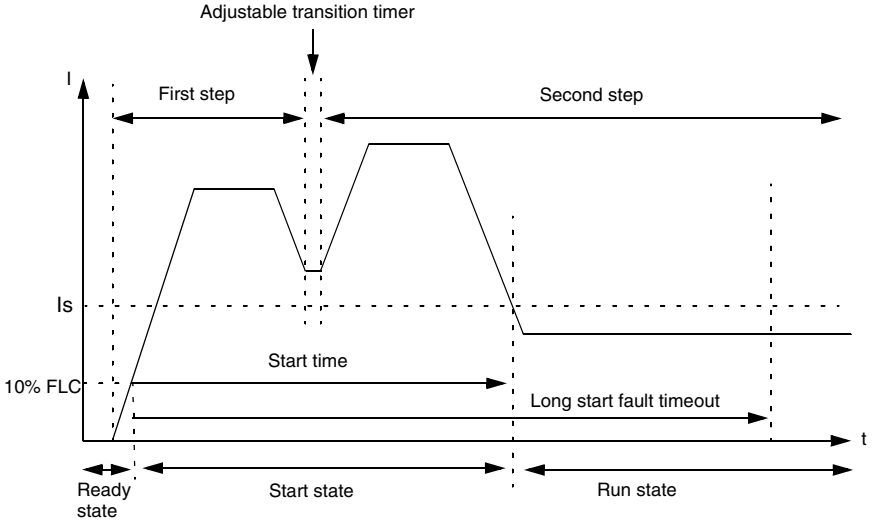
- Current rises above, then drops below, the fault threshold.
- The LTM R controller reports the actual start cycle time, i.e. the time elapsed from detection of On Level Current until the maximum phase current drops below the fault threshold.

Start cycle with 2 threshold crosses, single step:



Is Long start fault threshold

Start cycle with 2 threshold crosses, 2 step:

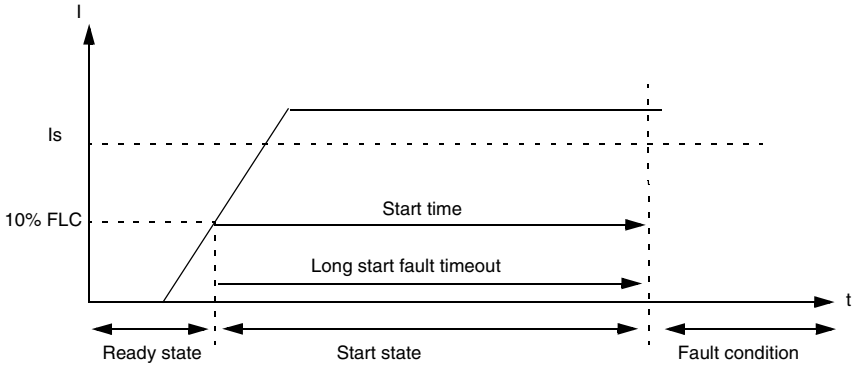


1 Threshold Cross

In this start cycle scenario, the start cycle fails:

- Current rises above, but fails to drop below, the Long Start Fault Threshold.
- If Long Start protection is enabled, the LTM R controller signals a fault when the Long Start Fault Timeout is reached
- If Long Start protection is disabled, the LTM R controller does not signal a fault and the run cycle begins after the Long Start Fault Timeout has expired.
- Other motor protection functions begin their respective duration times after the Long Start Fault Timeout.
- The LTM R controller reports start cycle time as 9999, indicating that current exceeded and remained above the fault threshold.
- The LTM R controller reports the maximum current detected during the start cycle.

Start cycle with 1 threshold cross:

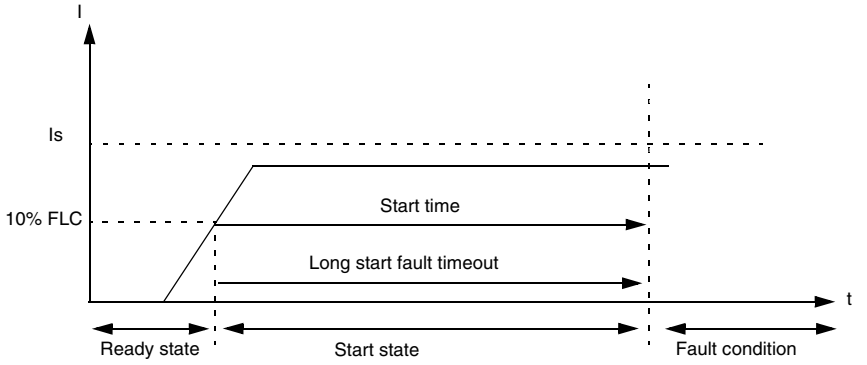


0 Threshold Cross

In this start cycle scenario, the start cycle fails:

- Current never rises above the fault threshold.
- If Long Start protection is enabled, the LTM R controller signals a fault when the Long Start Fault Timeout is reached
- If Long Start protection is disabled, the LTM R controller does not signal a fault and the run cycle begins after the Long Start Fault Timeout has expired.
- Other motor protection functions begin their respective duration times after the Long Start Fault Timeout.
- The LTM R controller reports both the start cycle time and the maximum current detected during start cycle as 0000, indicating current never reached the fault threshold.

Start cycle with 0 threshold crosses:



Is Long start fault threshold

5.2 Operating Modes

At a Glance

Summary

The LTM R controller can be configured to 1 of 10 predefined operating modes. Selecting custom operating mode allows you to select one of the 10 predefined operating modes and tailor it to your specific application, or to create an entirely new control program.

The selection of a predefined operating mode determines the behavior of all LTM R controller inputs and outputs.

Each predefined operating mode selection includes a control wiring selection:

- 2-wire (maintained), or
- 3-wire (impulse)

What's in this Section?

This section contains the following topics:

Topic	Page
Control Principles	223
Predefined Operating Modes	225
Control Wiring and Fault Management	228
Overload Operating Mode	230
Independent Operating Mode	233
Reverser Operating Mode	237
Two-Step Operating Mode	241
Two-Speed Operating Mode	247
Custom Operating Mode	252

Control Principles

Overview

The LTM R controller performs control and monitoring functions for single-phase and 3-phase electric motors.

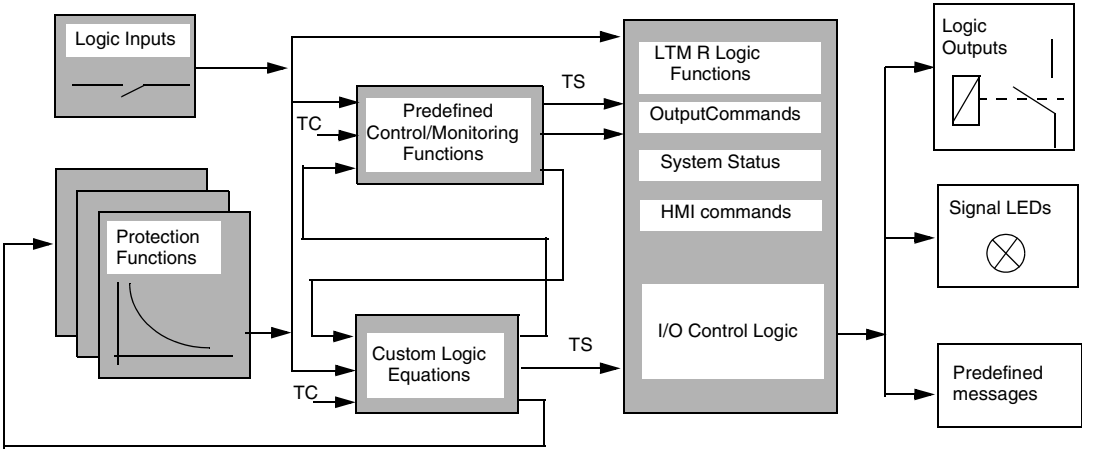
- These functions are predefined and fit the applications most frequently used. They are ready to use and are implemented by simple parameter setting after the LTM R controller has been commissioned.
- The predefined control and monitoring functions can be adapted for particular needs using the custom logic editor in PowerSuite™ software to:
  - edit protection functions
  - change the operation of control and monitoring functions
  - alter the default LTM R controller I/O logic

Operating Principle

The processing of control and monitoring functions has 3 parts:

- acquisition of input data:
  - the output of protection function processing
  - external logic data from logic inputs
  - telecommunication commands (TC) received from the control source
- logic processing by the control or monitoring function
- utilization of the processing results:
  - activation of logic outputs
  - display of predefined messages
  - activation of LEDs
  - telecommunication signals (TS) sent via a communications link.

The control and monitoring function process is displayed below:



Logic Inputs and Outputs

The LTM R controller provides 6 logic inputs, 2 logic outputs, 1 warning relay and 1 fault relay. By adding an expansion module, you can add 4 more logic inputs.

Selecting a predefined operating mode automatically assigns the logic inputs to functions and defines the relationship between logic inputs and outputs. Using the custom logic editor, you can change these assignments.

Predefined Operating Modes

Overview

The LTM R controller can be configured in 1 of 10 predefined operating modes. Each operating mode is designed to meet the requirements of a common application configuration.

When you select an operating mode, you specify both the:

- operating mode type, which determines the relationship between logic inputs and logic outputs, and
- control circuit type, which determines logic input behavior, based on the control wiring design.

Operating Mode Types

There are 5 types of operating modes:

Operating mode type	Best used for:
Overload	All motor starter applications in which the user defines assignment of: • logic inputs I.1, I.2, I.3 and I.4 • logic outputs O.1 and O.2 • Aux1, Aux2 and Stop commands from the HMI. The I/O can be defined using a control program managed by the master network controller in remote control, by an HMI tool, or by using custom logic.
Independent	Direct-on-line (across-the-line) full-voltage non-reversing motor starting applications
Reverser	Direct-on-line (across-the-line) full-voltage reversing motor starting applications
Two-Step	Reduced voltage starting motor applications, including: • Wye-Delta • Open Transition Primary Resistor • Open Transition Autotransformer
Two-Speed	Two-speed motor applications for motor types, including: • Dahlander (consequent pole) • Pole Changer

Logic Input Behavior

When you select an operating mode, you also specify that logic inputs are wired for either 2-wire (maintained) or 3-wire (impulse) control. Your selection determines the valid start and stop commands from the various control sources, and sets the behavior of the input command following the return of power after an outage:

Control Circuit Type	Behavior of logic inputs I.1 and I.2
2-wire (maintained)	The LTM R controller, after detecting the rising edge on the input assigned to start the motor, issues a run command. The run command remains active only while the input is active. The signal is not latched.
3-wire (impulse)	The LTM R controller: ● after detecting the rising edge on the input assigned to start the motor, latches the run command, and ● after a stop command, disables the run command to disable the output relay wired in series with the coil of the contactor that turns the motor on or off ● following a stop, must detect a rising edge on the input to latch the run command.

Control logic assignments for logic inputs I.1, I.2, I.3 and I.4 are described in each of the predefined motor operating modes.

Note: In Network control mode, network commands behave as 2-wire control commands, regardless of the control circuit type of the selected operating mode. For information on Control Modes, see *p. 210*.

In each pre-defined operating mode, logic inputs I.3, I.4, I.5 and I.6 behave as follows:

Logic Input	Behavior
I.3	User defined.
I.4	● In 3-wire (impulse) control: a Stop command. ● In 2-wire (maintained) control: a user-defined input that can be configured to send information to a PLC address over the network. Note: In Overload operating mode, logic input I.4 is not used and can be user-defined.
I.5	A Fault Reset command is recognized when this input receives the rising edge of a signal. **Note:** this input must first become inactive, and then receive the rising edge of a subsequent signal, for another reset to occur.
I.6	Local/Remote control of the LTM R controller's outputs: ● Active: Remote control by the PLC over the network. ● Inactive: Local control through either the terminal strip or the local HMI port, as determined by the Control Local Channel Setting parameter.

Logic Output Behavior

The behavior of logic outputs O.1 and O.2 is determined by the selected operating mode. See the topics that follow for a description of the 5 pre-defined operating mode types and the behavior of logic outputs O.1 and O.2.

When the LTM R controller has lost communication with either the network or the local HMI, the LTM R controller enters a fallback condition. When it receives a stop command in a fallback condition, logic outputs O.1 and O.2 behave as follows:

Control Circuit Type	Response of logic outputs O.1 and O.2 to a stop command
2-wire (maintained)	A stop command overrides the fallback condition and turns off logic outputs O.1 and O.2 while the stop command is active. After the stop command is no longer active, logic outputs O.1 and O.2 return to their programmed fallback state.
3-wire (impulse)	A stop command overrides the fallback condition and turns off logic outputs O.1 and O.2. The outputs remain off after the stop command is removed and do not return to their programmed fallback state.

For information on configuring fallback-related parameters, see *p. 107*.

In all operating mode types, the following logic outputs behave as described below:

Logic Output	Behavior
O.3	Activated by any enabled protection warning: • Terminals NO 33-34
O.4	Activated by any enabled protection fault: • Terminals NC 95-96 • Terminals NO 97-98 **Note:** When control voltage is too low or off: • NC 95-96 open • NO 97-98 close

Control Wiring and Fault Management

Overview

When Overload predefined operating mode is selected, the LTM R controller does not latch logic output commands unless directed by either a PLC master control program or the LTM R controller's custom logic program.

For all other predefined operating modes–Independent, Reverser, 2-Step, and 2-Speed–the predefined control logic in the LTM R controller is designed to meet the the objectives of many common motor starting applications. This includes managing motor behavior in response to:

- start and stop actions, and
- fault and reset actions

Because the LTM R controller can be used in special applications–such as fire pumps that require the motor to run despite a known fault condition–the predefined control logic is designed so that the control circuit, and not the predefined control logic, determines how the LTM R controller interrupts current flow to the contactor coil.

Control Logic Action on Starts and Stops

Predefined control logic acts upon start and stop commands as follows:

- For all 3-wire (impulse) control wiring diagrams, when input 4 is configured as a stop command, the LTM R controller must detect input current at logic input I.4 in order to act on a start command.
- If logic input I.4 is active and a user start action initiates current at logic inputs I.1 or I.2, the LTM R controller detects the rising edge of the current and sets an internal (firmware) latch command that directs the appropriate relay output to close and remain closed until the latch command is disabled.
- A stop action that interrupts current at logic input I.4, causes the LTM R controller to disable the latch command. Disabling the firmware latch causes the output to open–and remain open–until the next valid start condition.
- For all 2-wire (maintained) control wiring diagrams, the LTM R controller detects the presence of current at logic inputs I.1 or I.2 as start commands, and the absence of current disables the start command.

Control Logic Action on Faults and Resets

Predefined control logic manages faults and reset commands as follows:

- Logic output O.4 opens in response to a fault condition.
- Logic output O.4 closes in response to a reset command.

Control Logic and Control Wiring Together Managing Faults

The control circuits, shown in the wiring diagrams in this chapter and in the Appendix, indicate how the LTM R controller's control logic and the control circuit combine to stop a motor in response to a fault:

- For 3-wire (impulse) control circuits, the control strategy links the state of logic output O.4 to the state of the current at logic input I.4:
  - Control logic opens logic output O.4 in response to a fault.
  - Logic output O.4 opening interrupts current at logic input I.4, disabling the control logic latch command on logic output O.1.
  - Logic output O.1 opens– due to control logic described above–and stops the flow of current to the contactor coil.

  In order to restart the motor, the fault must be reset and a new start command must be issued.
- For 2-wire (maintained) control circuits, the control strategy links the state of logic output O.4 directly with the logic inputs I.1 or I.2.
  - Control logic opens logic output O.4 in response to a fault.
  - Logic output O.4 opening interrupts current to the logic inputs I.1 or I.2
  - Control logic disables the start commands opening logic outputs O.1 or O.2.

  In order to restart the motor, the fault must be reset and the state of Start/Stop operators determines the state of logic inputs I.1 or I.2.

The control circuits needed to run a motor - during a motor protection fault, are not shown in the wiring diagrams that follow. However, the control strategy is to not link the state of logic output O.4 to the state of the input commands. In this way, fault conditions may be annunciated, while control logic continues to manage Start and Stop commands.

Overload Operating Mode

Description

Use Overload operating mode when motor load monitoring is required and motor load control (start/stop) is performed by a mechanism other than the LTM R controller.

Functional Characteristics

The Overload operating mode includes the following features:

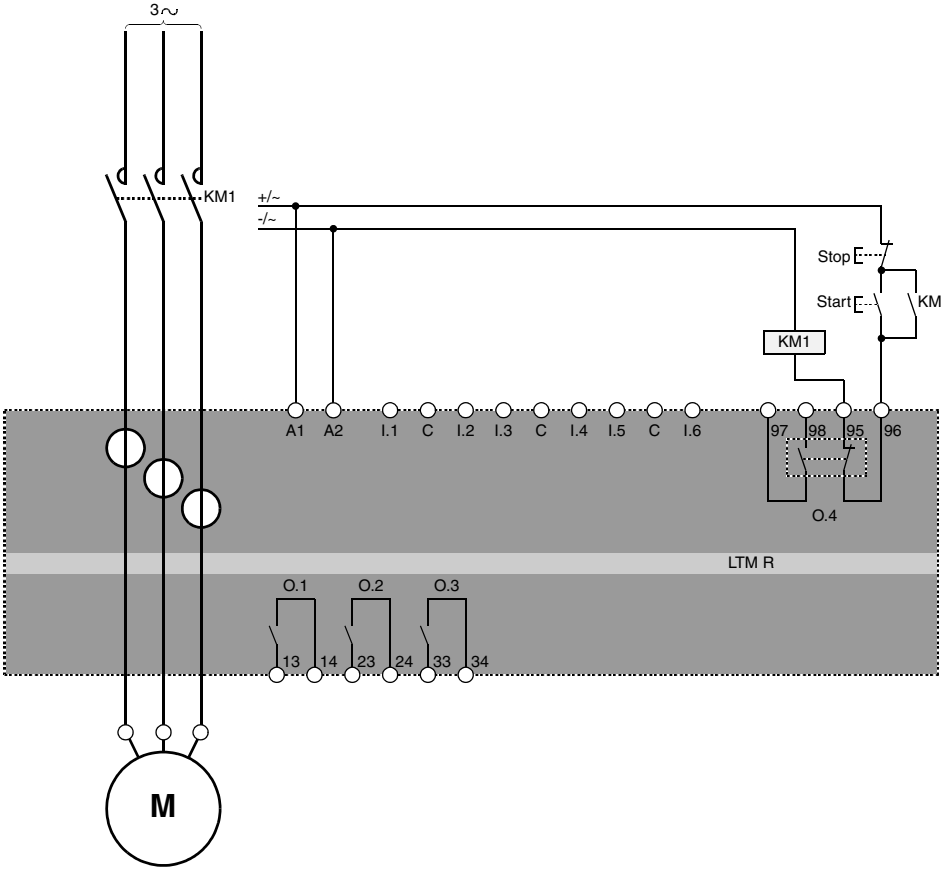
- Accessible only in Network control mode.
- Logic output O.4 opens in response to a diagnostic error.
- The LTM R controller sets a bit in a status word when it detects an active signal in:
  - logic inputs I.1, I.2, I.3, or I.4, or
  - the Aux 1, Aux 2, or Stop buttons on the HMI keypad.

  Note: When a bit is set in the input status word, it can be read by a PLC which can write a bit to the LTM R controller's command word. When the LTM R controller detects a bit in its command word, it can turn on the respective output (or outputs).

Note: The LTM R controller does not latch logical output commands unless directed by a PLC master control program, or a custom logic program.

Overload Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a 3-wire (impulse) local-control overload application.



For additional examples of overload operating mode IEC diagrams, see *p. 513*.

For examples of overload operating mode NEMA diagrams, see *p. 533*.

I/O Assignment

Overload operating mode provides the following logic inputs:

Logic inputs	Assignment
I.1	Free
I.2	Free
I.3	Free
I.4	Free
I.5	Reset
I.6	Local (0) or network (1)

Overload operating mode provides the following logic outputs:

Logic outputs	Assignment
O.1 (13 and 14)	Responds to network control commands
O.2 (23 and 24)	Responds to network control commands
O.3 (33 and 34)	Warning signal
O.4 (95, 96, 97, and 98)	Fault signal

Overload operating mode uses the following HMI keys:

HMI keys	Assignment
Aux 1	Free
Aux 2	Free
Stop	Free

Parameters

Overload operating mode requires no associated parameter settings.

Independent Operating Mode

Description

Use Independent operating mode in single direct-on-line (across-the-line) full-voltage, non-reversing motor starting applications.

Functional Characteristics

This function includes the following features:

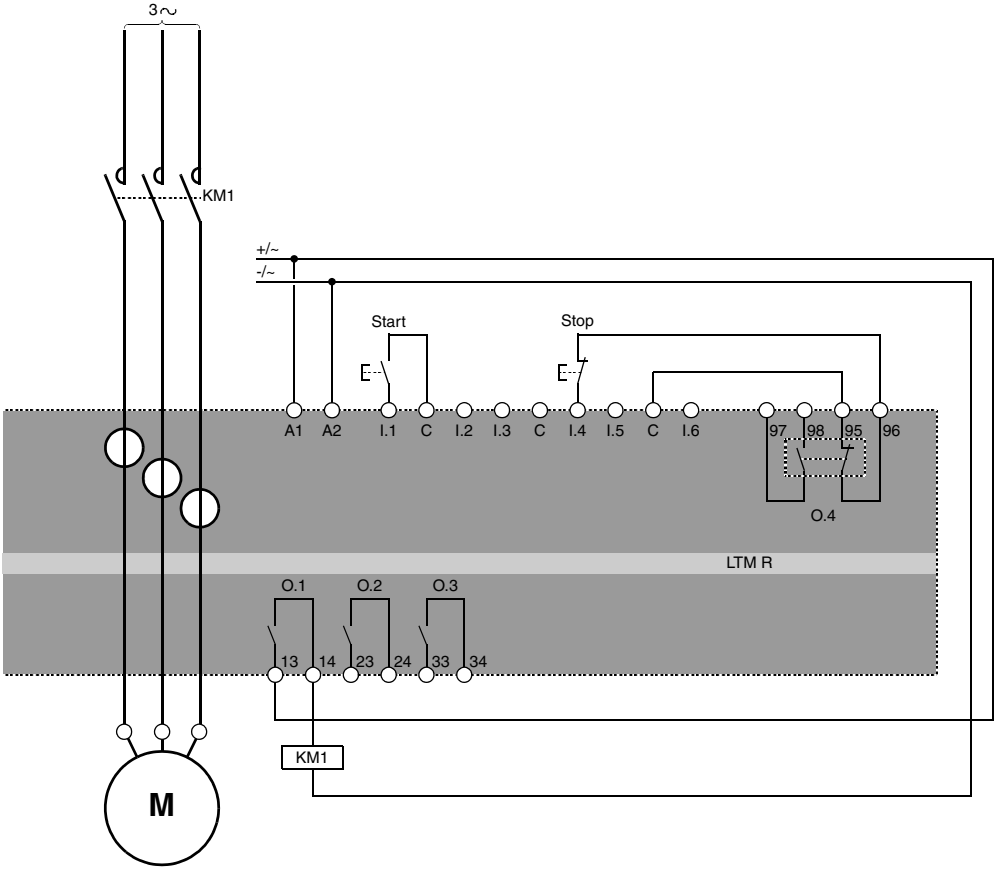
- Accessible in 3 control modes: Local Terminal Strip, Local HMI, and Network.
- The LTM R controller does not manage the relationship between logic outputs O.1 and O.2.
- In local terminal strip control mode, logic input I.1 controls logic output O.1, and logic input I.2 controls logic output O.2.
- In network or local HMI control modes, the Motor Run Forward Command parameter controls logic output O.1 and the Logic Output 23 Command parameter controls logic output O.2.
- Logic input I.3 is not used in the control circuit, but can be configured to set a bit in memory.
- Logic outputs O.1 and O.2 deactivate–and the motor stops–when control voltage becomes too low.
- Logic outputs O.1 and O.4 deactivate–and the motor stops–in response to a diagnostic error.

Note: See *Control Wiring and Fault Management, p. 228* for information about the interaction between:

- the LTM R controller's predefined control logic, and
- the control wiring, an example of which appears in the following diagram

Independent Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in an independent local-control 3-wire (impulse) application.



For additional examples of independent operating mode IEC diagrams, see *p. 517*.

For examples of independent operating mode NEMA diagrams, see *p. 537*.

I/O Assignment

Independent operating mode provides the following logic inputs:

Logic inputs	2-wire (maintained) assignment	3-wire (impulse) assignment
I.1	Start/Stop motor	Start motor
I.2	Open/Close O.2	Close O.2
I.3	Free	Free
I.4	Free	Stop motor and open O.1 and O.2
I.5	Reset	Reset
I.6	Local (0) or network (1)	Local (0) or network (1)

Independent operating mode provides the following logic outputs:

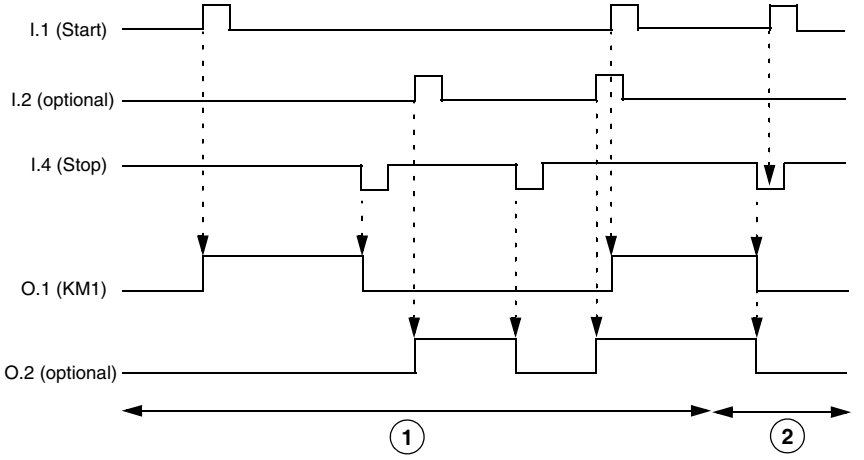
Logic outputs	Assignment
O.1 (13 and 14)	KM1 contactor control
O.2 (23 and 24)	Controlled by I.2
O.3 (33 and 34)	Warning signal
O.4 (95, 96, 97, and 98)	Fault signal

Independent operating mode uses the following HMI keys:

HMI keys	2-wire (maintained) assignment	3-wire (impulse) assignment
Aux 1	Control motor	Start motor
Aux 2	Control O.2	Close O.2
Stop	Stop motor and open O.2 while pressed	Stop motor and open O.2

Timing Sequence

The following diagram is an example of the timing sequence for the Independent operating mode that shows the inputs and outputs for a 3-wire (impulse) configuration:



1 Normal operation
2 Start command ignored: stop command active

Parameters

Independent operating mode requires no associated parameters.

Reverser Operating Mode

Description

Use Reverser operating mode in direct-on-line (across-the-line) full-voltage, reversing motor starting applications.

Functional Characteristics

This function includes the following features:

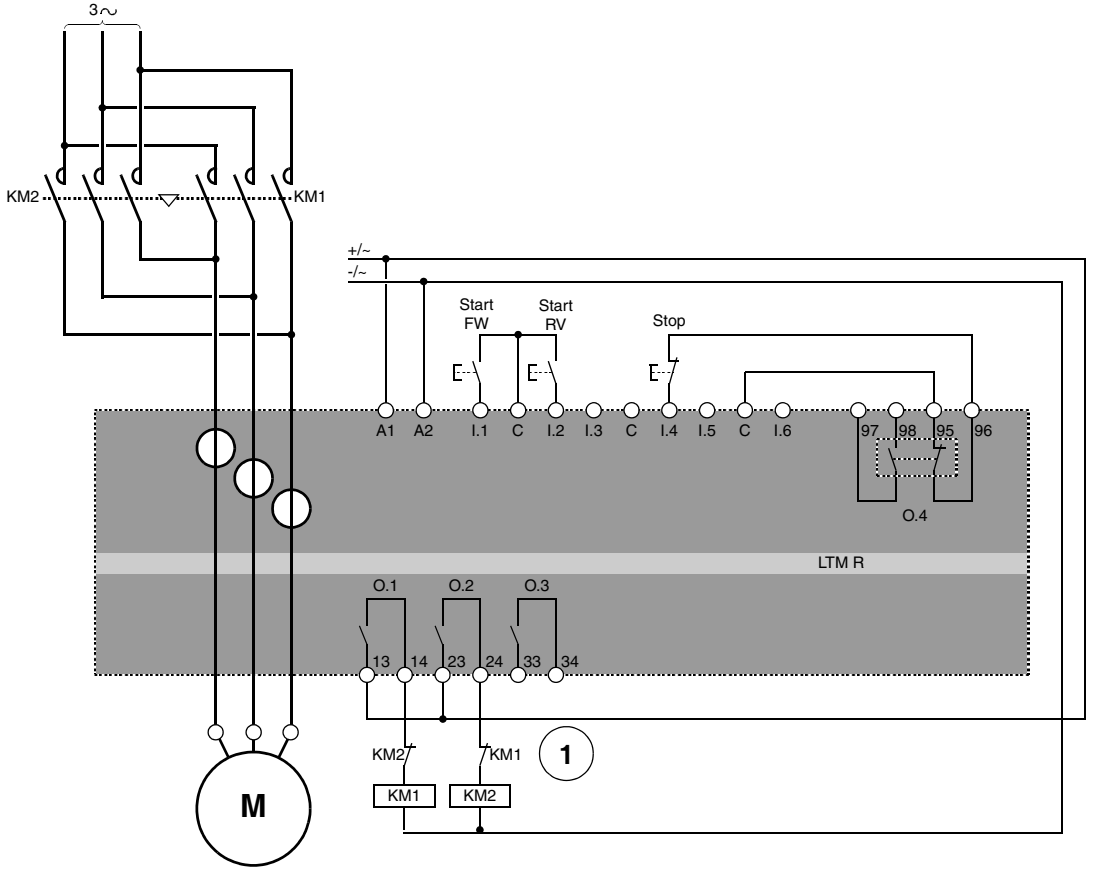
- Accessible in 3 control modes: Local Terminal Strip, Local HMI, and Network.
- Firmware interlocking prevents simultaneous activation of the O.1 (forward) and O.2 (reverse) logic outputs.
- The LTM R controller can change direction from forward to reverse and reverse to forward in 1 of 2 modes:
  - Standard Transition mode: The Control Direct Transition bit is Off. This mode requires a Stop command followed by count-down of the adjustable Motor Transition Timeout (anti-backspin) timer.
  - Direct Transition mode: The Control Direct Transition bit is On. This mode automatically transitions after the count-down of the adjustable Motor Transition Timeout (anti-backspin) timer.
- In local terminal strip control mode, logic input I.1 controls logic output O.1, and logic input I.2 controls logic output O.2.
- In network or local HMI control modes, the Motor Run Forward Command parameter controls logic output O.1 and the Motor Run Reverse Command controls logic output O.2.
- Logic input I.3 is not used in the control circuit, but can be configured to set a bit in memory.
- Logic outputs O.1 and O.2 deactivate–and the motor stops–when control voltage becomes too low.
- Logic outputs O.1, O.2 and O.4 deactivate–and the motor stops–in response to a diagnostic error.

Note: See *Control Wiring and Fault Management, p. 228* for information about the interaction between:

- the LTM R controller's predefined control logic, and
- the control wiring, an example of which appears in the following diagram

Reverser Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a Reverser local-control 3-wire (impulse) application.



1 The N.C. interlock contacts KM1 and KM2 are not mandatory because the LTM R controller firmware interlocks O.1 and O.2.

For additional examples of reverser operating mode IEC diagrams, see *p. 519*.

For examples of reverser operating mode NEMA diagrams, see *p. 539*.

I/O Assignment

Reverser operating mode provides the following logic inputs:

Logic inputs	2-wire (maintained) assignment	3-wire (impulse) assignment
I.1	Forward run	Start motor forward
I.2	Reverse run	Start motor reverse
I.3	Free	Free
I.4	Free	Stop motor
I.5	Reset	Reset
I.6	Local (0) or network (1)	Local (0) or network (1)

Reverser operating mode provides the following logic outputs:

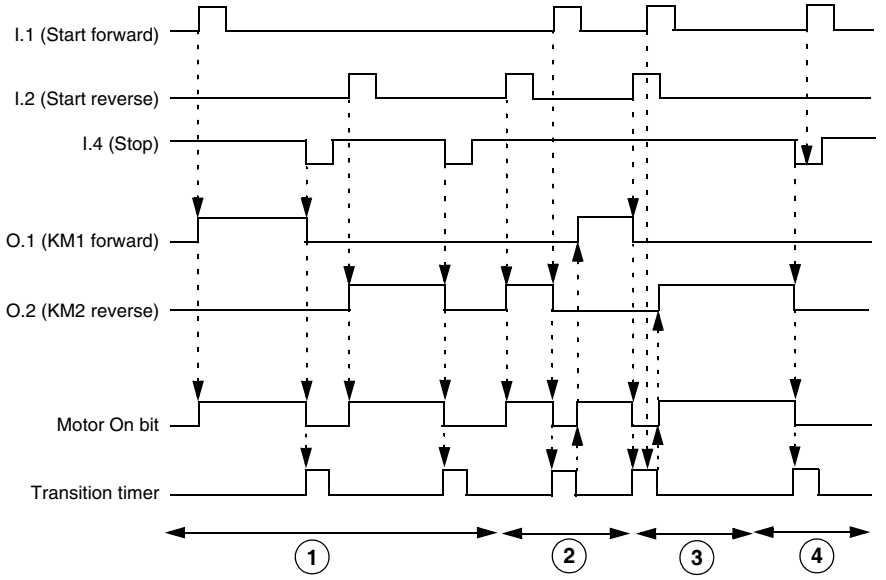
Logic outputs	Assignment
O.1 (13 and 14)	KM1 contactor control Forward
O.2 (23 and 24)	KM2 contactor control Reverse
O.3 (33 and 34)	Warning signal
O.4 (95, 96, 97, and 98)	Fault signal

Reverser operating mode uses the following HMI keys:

HMI keys	2-wire (maintained) assignment	3-wire (impulse) assignment
Aux 1	Forward run	Start motor forward
Aux 2	Reverse run	Start motor reverse
Stop	Stop while pressed	Stop

Timing Sequence

The following diagram is an example of the timing sequence for the Reverser operating mode that shows the inputs and outputs for a 3-wire (impulse) configuration when the control direct transition bit is On:



1 Normal operation with stop command
2 Normal operation without stop command
3 Forward run command ignored: transition timer active
4 Forward run command ignored: stop command active

Parameters

Reverser operating mode has the following parameters:

Parameters	Setting range	Factory setting
Motor transition timeout	0…999.9 s	0.1 s
Control direct transition	On/Off	Off

Two-Step Operating Mode

Description

Use Two-Step operating mode in reduced voltage starting motor applications such as:

- Wye-Delta
- Open Transition Primary Resistor
- Open Transition Autotransformer

Note: For Wye-Delta applications, calculate the Motor Full Load Current setting as follows:

$$\text{Motor Full Load Current} = \frac{\text{MotorRatedCurrent}}{\sqrt{3}}$$

Functional Characteristics

This function includes the following features:

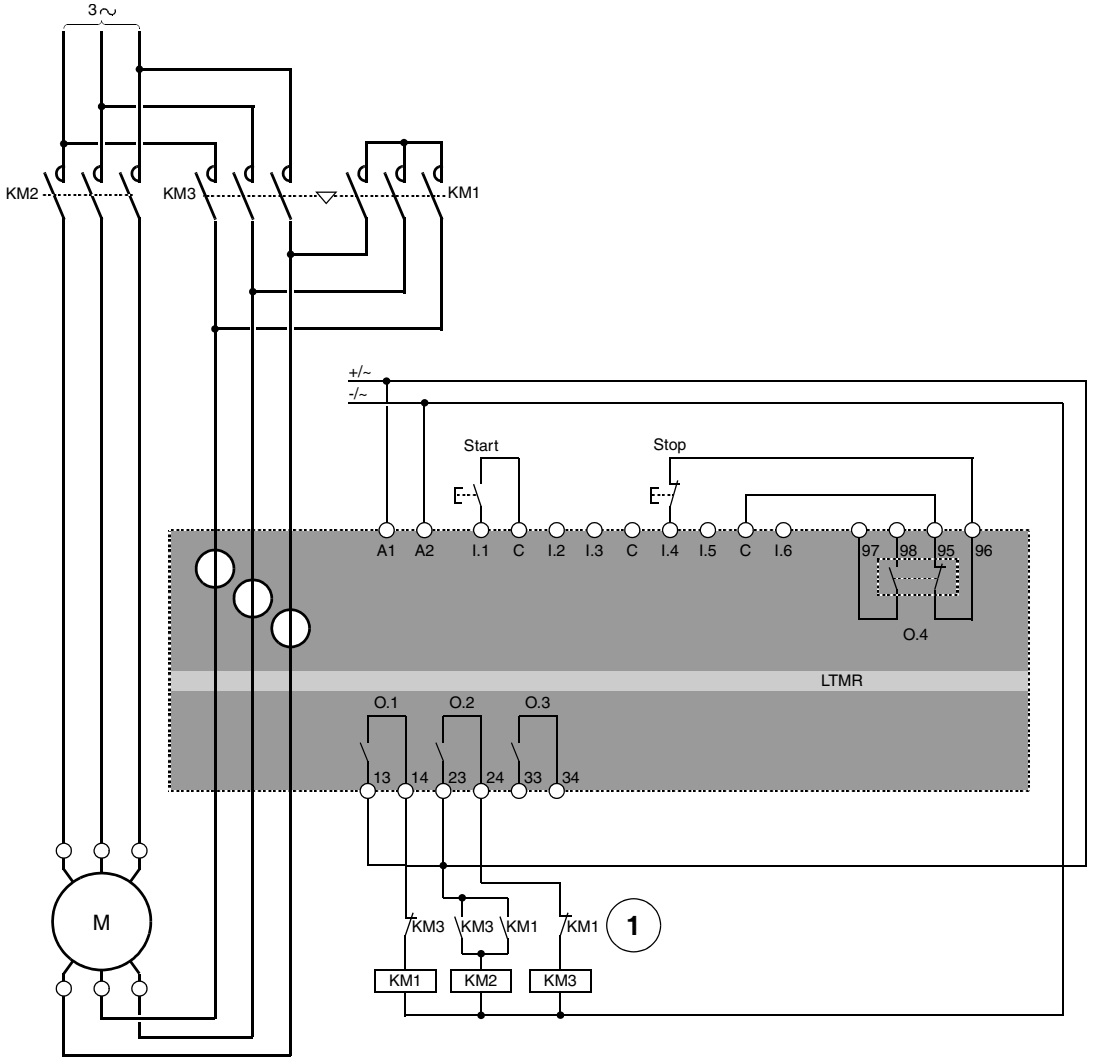
- Accessible in 3 control modes: Local Terminal Strip, Local HMI, and Network.
- Two-Step operation settings include:
  - A Motor Step 1 To 2 Timeout that starts when current reaches 10% of FLC min.
  - A Motor Step 1 To 2 Threshold setting.
  - A Motor Transition Timeout setting that starts upon the earlier of the following events: expiration of the Motor Step 1 To 2 Timeout, or current falling below the Motor Step 1 To 2 Threshold.
- Firmware interlocking prevents simultaneous activation of O.1 (step 1) and O.2 (step 2) logic outputs.
- In local terminal strip control mode, logic input I.1 controls logic outputs O.1 and O.2.
- In network or local HMI control modes, the Motor Run Forward Command parameter controls logic outputs O.1 and O.2. The Motor Run Reverse Command parameter is ignored.
- Logic outputs O.1 and O.2 deactivate–and the motor stops–when control voltage becomes too low.
- Logic outputs O.1, O.2 and O.4 deactivate–and the motor stops–in response to a diagnostic error.

Note: See *Control Wiring and Fault Management, p. 228* for information about the interaction between:

- the LTM R controller's predefined control logic, and
- the control wiring, an example of which appears in the following diagrams

Two-Step Wye-Delta Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-step Wye-Delta local-control 3-wire (impulse) application.



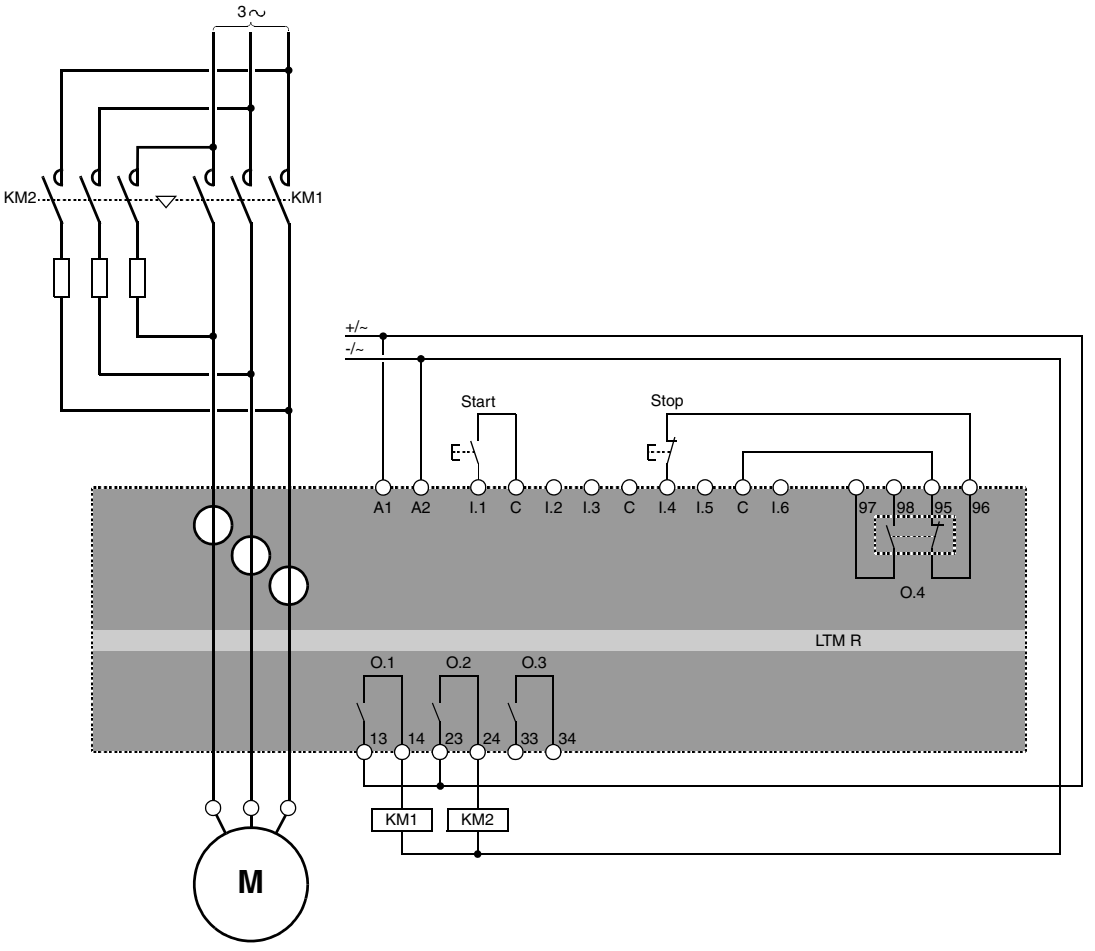
1 The N.C. interlock contacts KM1 and KM3 are not mandatory because the LTM R controller electronically interlocks O.1 and O.2.

For additional examples of two-step Wye-Delta IEC diagrams, see *p. 521*.

For examples of two-step Wye-Delta NEMA diagrams, see *p. 541*.

Two-Step Primary Resistor Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-step local-control 3-wire (impulse) primary resistance application.

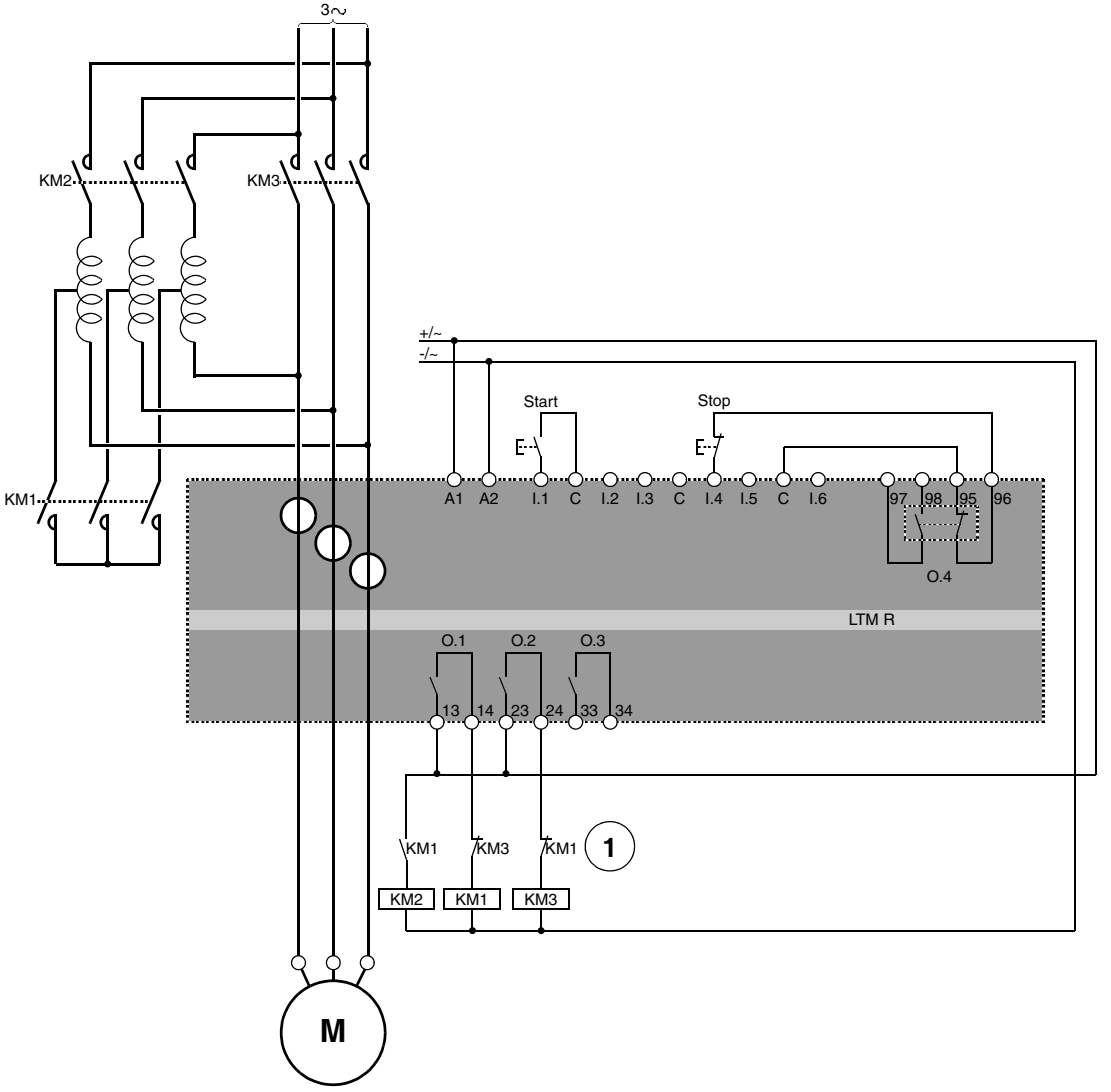


For additional examples of two-step primary resistor IEC diagrams, see *p. 523*.

For examples of two-step primary resistor NEMA diagrams, see *p. 543*.

Two-Step Autotransformer Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-step local-control 3-wire (impulse) autotransformer application.



1 The N.C. interlock contacts KM1 and KM3 are not mandatory because the LTM R controller electronically interlocks O.1 and O.2.

For additional examples of two-step autotransformer IEC diagrams, see *p. 525*.

For examples of two-step autotransformer NEMA diagrams, see *p. 545*.

I/O assignment

Two-step operating mode provides the following logic inputs:

Logic inputs	2-wire (maintained) assignment	3-wire (impulse) assignment
I.1	Control motor	Start motor
I.2	Free	Free
I.3	Free	Free
I.4	Free	Stop motor
I.5	Reset	Reset
I.6	Local (0) or network (1)	Local (0) or network (1)

Two-step operating mode provides the following logic outputs:

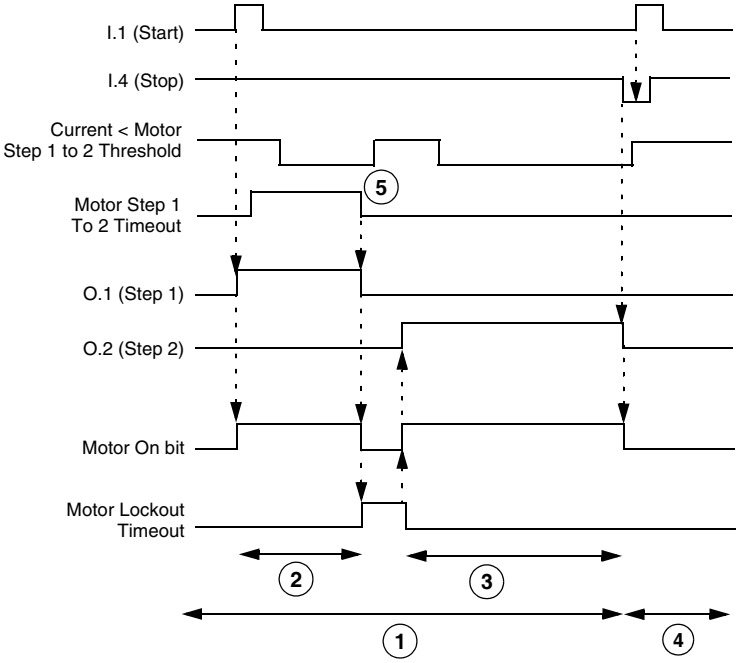
Logic outputs	Assignment
O.1 (13 and 14)	Step 1 contactor control
O.2 (23 and 24)	Step 2 contactor control
O.3 (33 and 34)	Warning signal
O.4 (95, 96, 97, and 98)	Fault signal

Two-step operating mode uses the following HMI keys:

HMI keys	2-wire (maintained) assignment	3-wire (impulse) assignment
Aux 1	Control motor	Start motor
Aux 2	Free	Free
Stop	Stop motor while pressed	Stop motor

Timing Sequence

The following diagram is an example of the timing sequence for the Two-Step operating mode that shows the inputs and outputs for a 3-wire (impulse) configuration:



1 Normal operation
2 Step 1 start
3 Step 2 start
4 Start command ignored: Stop command active
5 Current falling below the Motor Step 1 To 2 Threshold ignored: preceded by expiration of the Motor Step 1 To 2 Timeout.

Parameters

Two-step operating mode has the following parameters:

Parameter	Setting range	Factory setting
Motor step 1 to 2 timeout	0…999.9 s	5 s
Motor transition timeout	0…999.9 s	100 ms
Motor step 1 to 2 threshold	20-800% FLC in 1% increments	150% FLC

Two-Speed Operating Mode

Description

Use Two-Speed operating mode in two-speed motor applications for motor types such as:

- Dahlander (consequent pole)
- Pole Changer

Functional Characteristics

This function includes the following features:

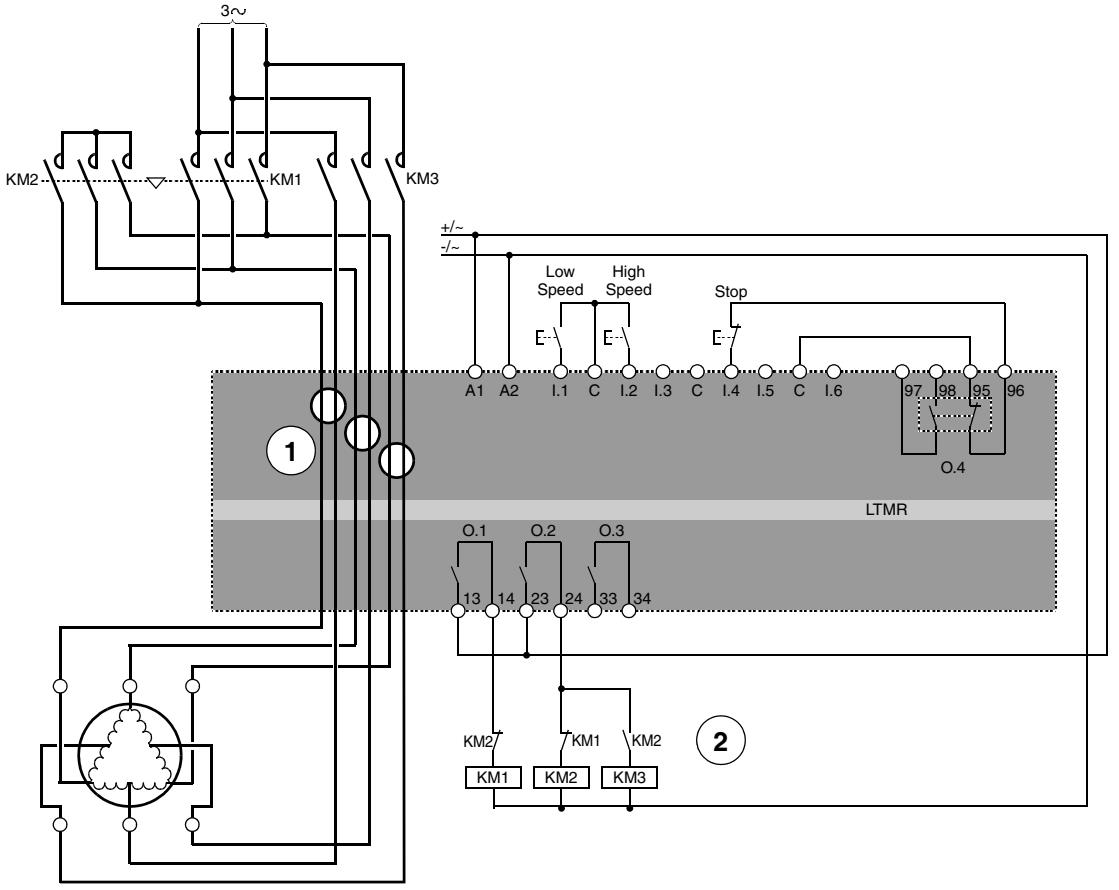
- Accessible in 3 control modes: Local Terminal Strip, Local HMI, and Network.
- Firmware interlocking prevents simultaneous activation of O.1 (low speed) and O.2 (high speed) logic outputs.
- Two measures of FLC:
  - FLC1 (Motor Full Load Current Ratio) at low speed
  - FLC2 (Motor High Speed Full Load Current Ratio) at high speed
- The LTM R controller can change speed in two scenarios:
  - The Control Direct Transition bit is Off: requires a Stop command followed by expiration of the Motor Transition Timeout.
  - The Control Direct Transition bit is On: automatically transitions from high speed to low speed after a time-out of the adjustable Motor Transition Timeout.
- In local terminal strip control mode, logic input I.1 controls logic output O.1, and logic input I.2 controls logic output O.2.
- In network or local HMI control modes, when the Motor Run Forward Command parameter is set to 1 and:
  - Motor Low Speed Command is set to 1, logic output O.1 is enabled.
  - Motor Low Speed Command is set to 0, logic output O.2 is enabled.
- Logic input I.3 is not used in the control circuit, but can be configured to set a bit in memory.
- Logic outputs O.1 and O.2 deactivate–and the motor stops–when control voltage becomes too low.
- Logic outputs O.1, O.2 and O.4 deactivate–and the motor stops– in response to a diagnostic error.

Note: See *Control Wiring and Fault Management, p. 228* for information about the interaction between:

- the LTM R controller's predefined control logic, and
- the control wiring, an example of which appears in the following diagrams

Two-Speed Dahlander Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-speed Dahlander consequent pole local-control 3-wire (impulse) application.



1 A Dahlander application requires two sets of wires passing through the CT windows. The LTM R controller can also be placed upstream of the contactors. If this is the case, and if the Dahlander motor is used in variable torque mode, all the wires downstream of the contactors must be the same size.

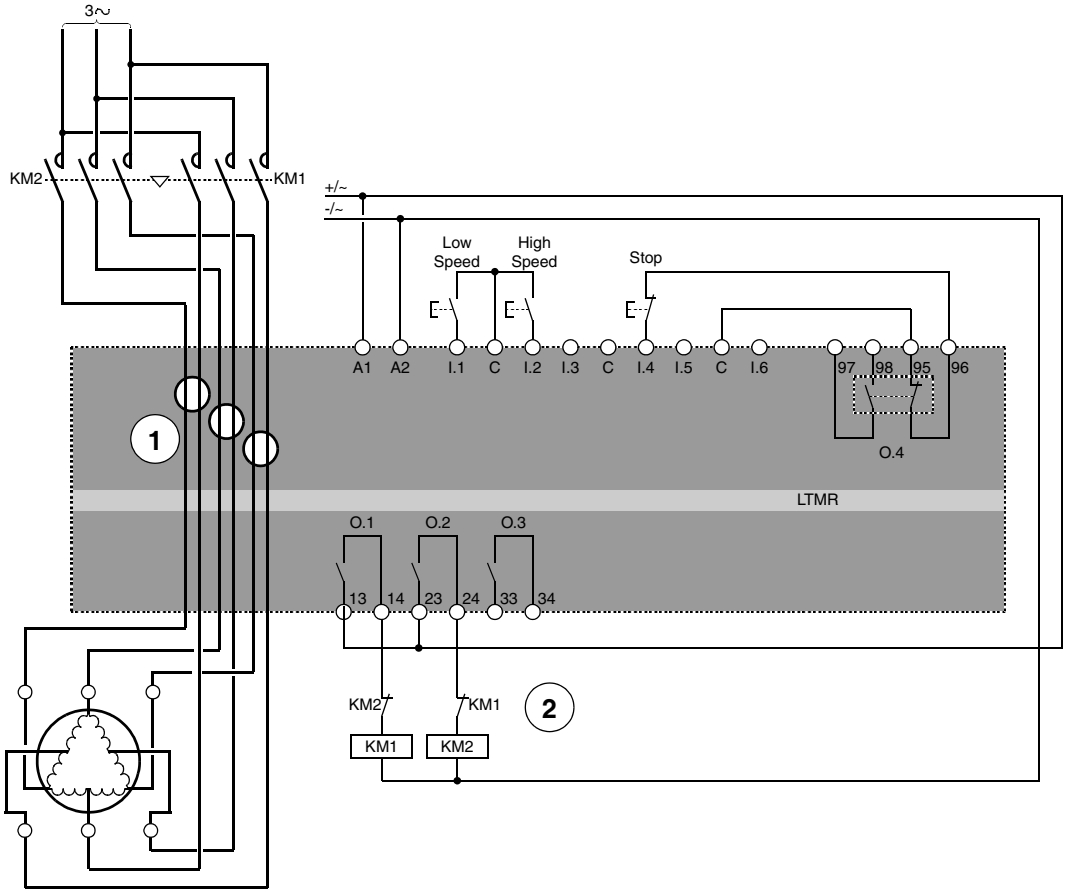
2 The N.C. interlock contacts KM1 and KM2 are not mandatory because the LTM R controller firmware interlocks O.1 and O.2.

For additional examples of two-speed Dahlander IEC diagrams, see *p. 527*.

For examples of two-speed Dahlander NEMA diagrams, see *p. 547*.

2-Speed Pole-Changing Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-speed pole-changing local-control 3-wire (impulse) application.



1 A pole-changing application requires two sets of wires passing through the CT windows. The LTM R controller can also be placed upstream of the contactors. If this is the case, all the wires downstream of the contactors must be the same size.

2 The N.C. interlock contacts KM1 and KM2 are not mandatory because the LTM R controller firmware interlocks O.1 and O.2.

For additional examples of pole-changing IEC diagrams, see *p. 529*.

For examples of pole-changing NEMA diagrams, see *p. 549*.

I/O Assignment

Two-Speed operating mode provides the following logic inputs:

Logic inputs	2-wire (maintained) assignment	3-wire (impulse) assignment
I.1	Low speed command	Low speed start
I.2	High speed command	High speed start
I.3	Free	Free
I.4	Free	Stop
I.5	Reset	Reset
I.6	Local (0) or network (1)	Local (0) or network (1)

Two-Speed operating mode provides the following logic outputs:

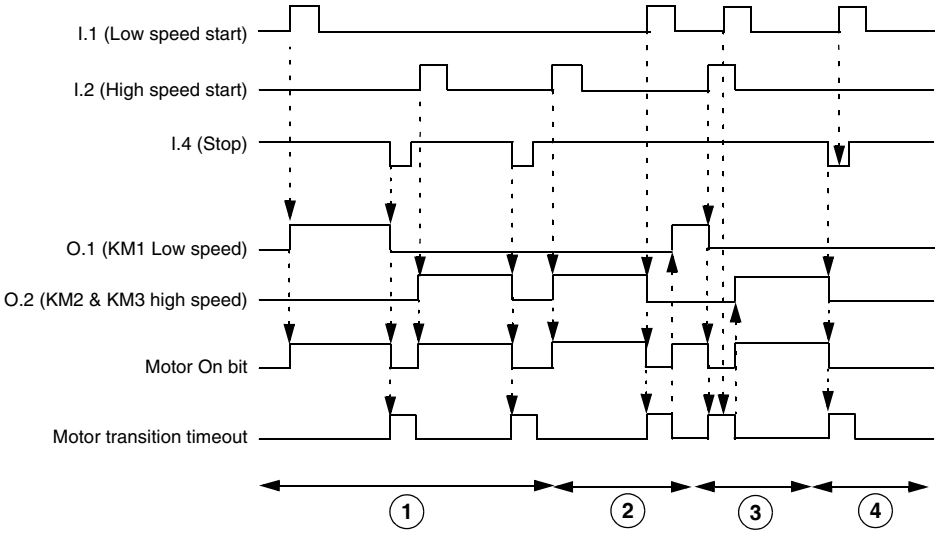
Logic outputs	Assignment
O.1 (13 and 14)	Low speed control
O.2 (23 and 24)	High speed control
O.3 (33 and 34)	Warning signal
O.4 (95, 96, 97, and 98)	Fault signal

Two-speed operating mode uses the following HMI keys:

HMI keys	2-wire (maintained) assignment	3-wire (impulse) assignment
Aux 1	Low speed control	Low speed start
Aux 2	High speed control	High speed start
Stop	Stop the motor	Stop the motor

Timing Sequence

The following diagram is an example of the timing sequence for the two-speed operating mode that shows the inputs and outputs for a 3-wire (impulse) configuration when the Control Direct Transition bit is On:



1 Normal operation with stop command
2 Normal operation without stop command
3 Low-speed start command ignored: motor transition timeout active
4 Low-speed start command ignored: stop command active

Parameters

The following table lists the parameters associated with the Two-Speed operating mode.

Parameters	Setting range	Factory setting
Motor transition timeout (high speed to low speed)	0…999.9 s	100 ms
Control direct transition	On/Off	Off

Note: The low speed to high speed timer is fixed at 100 ms.

Custom Operating Mode

Overview

Custom operating mode can be implemented only by using the custom logic editor in PowerSuite™ software.

To select Custom operating mode, start in the configuration software's tree control. Navigate to the Settings → Motor → Motor Operating Mode page and select **Custom** as the Operating Mode. This sets the Motor Custom Operating Mode parameter.

Program files

Every LTM R controller program consists of two files:

- a configuration file that contains parameter configuration settings
- a logic file that contains a series of logic commands that manage LTM R controller behavior, including:
  - motor start and stop commands
  - motor transitions between steps, speeds and directions
  - the valid control source and transitions between control sources
  - fault and warning logic for relay outputs 1 and 2, and the HMI
  - terminal strip reset functions
  - PLC and HMI communication loss and fallback
  - load shed
  - rapid cycle
  - starting and stopping LTM R controller diagnostics

When a predefined operating mode is selected, the LTM R controller applies a predefined logic file that permanently resides in the LTM R controller.

When custom operating mode is selected, the LTM R controller uses a customized logic file created in the custom logic editor and downloaded to the LTM R controller from the configuration software.

Transferring files

Use the following commands to separately download (from the configuration software to the LTM R controller) your application's configuration file and customized logic file:

To download this file	Use this command
Configuration file with parameter settings that is open and displayed in the configuration software	**PC to Device** command in either the icon bar or the Link → File Transfer sub-menu.
Logic file with logic commands that is open and displayed in the custom logic editor	**Download Program to Device** command in either the icon bar or the Logic Functions menu.

5.3 Fault Management

At a Glance

Summary

This section describes how the LTM R controller manages the fault handling process, and explains:

- how to select a fault reset mode, and
- controller behavior for each fault reset mode selection.

What's in this Section?

This section contains the following topics:

Topic	Page
Fault Management - Introduction	254
Manual Reset	257
Automatic Reset	260
Remote Reset	265
Fault and Warning Codes	267

Fault Management - Introduction

Overview

When the LTM R controller detects a fault condition and activates the appropriate response, the fault becomes latched. Once a fault becomes latched, it remains latched—even if the underlying fault condition is eliminated—until cleared by a reset command.

The setting of the Fault Reset Mode parameter determines how the LTM R controller manages faults. The fault reset mode selections, listed below, are described in the topics that follow:

- Manual (the default setting)
- Automatic
- Remote

The fault reset mode cannot be changed while a fault remains active. All faults must be reset before the fault reset mode can be changed.

Fault Reset Methods

A Reset command can be issued using any of the following means:

- cycling power
- reset button on the LTM R controller
- reset button on the HMI keypad
- reset command from the HMI engineering tool
- logic input I.5
- a network command
- automatic reset

⚠ WARNING

RISK OF UNINTENDED OPERATION

When the LTM R controller is operating in 2-wire control with an active Run command, a Reset command will immediately restart the motor.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

Fault Specific Reset Behaviors

The LTM R controller's response to faults depends on the nature of the fault that has occurred and how the related protection function is configured. For example:

- Thermal faults can be reset after the Fault Reset Timeout counts down and the utilized thermal capacity falls below the Fault Reset Threshold level.
- If the fault includes a reset timeout setting, the timeout must fully count down before a reset command executes.
- Internal device faults can be reset only by cycling power.
- LTM R controller memory does not retain diagnostic and wiring faults after a power loss, but does retain all other faults after a power loss.
- Internal, diagnostic, and wiring faults cannot be automatically reset.
- All wiring and diagnostic faults can be manually reset by local reset methods.
- For diagnostic faults, network reset commands are valid only in remote (network) control mode.
- For wiring faults, network reset commands are not valid in any control mode.

Fault Characteristics

The LTM R controller fault monitoring functions save the status of communications monitoring and motor protection faults on a power loss so that these faults must be acknowledged and reset as part of an overall motor maintenance strategy.

Protection category	Monitored fault	LTM R controller	LTM R controller with expansion module	Saved on power loss
Diagnostic	Run Command Check	X	X	–
	Stop Command Check	X	X	–
	Run Check Back	X	X	–
	Stop Check Back	X	X	–
Wiring / configuration errors	PTC connection	X	X	–
	CT Reversal	X	X	–
	Voltage Phase Reversal	–	X	–
	Current Phase Reversal	X	X	–
	Voltage Phase Loss	–	X	–
	Phase Configuration	X	X	–
Internal	Stack Overflow	X	X	–
	Watchdog	X	X	–
	ROM Checksum	X	X	–
	EEROM	X	X	–
	CPU	X	X	–
	Internal Temperature	X	X	–

X Monitored
– Not monitored

Protection category	Monitored fault	LTM R controller	LTM R controller with expansion module	Saved on power loss
Thermal resistance (Motor temp sensor)	PTC Binary	X	X	X
	PTC Analog	X	X	X
	NTC Analog	X	X	X
Thermal overload	Definite	X	X	X
	Inverse Thermal	X	X	X
Current	Long Start	X	X	X
	Jam	X	X	x
	Current Phase Imbalance	X	X	X
	Current Phase Loss	X	X	X
	Overcurrent	X	X	X
	Undercurrent	X	X	X
	Internal Ground Current	X	X	X
	External Ground Current	X	X	X
Voltage	Overvoltage	–	X	X
	Undervoltage	–	X	X
	Voltage Phase Imbalance	–	X	X
Power	Underpower	–	X	X
	Overpower	–	X	X
	Under Power Factor	–	X	X
	Over Power Factor	–	X	X
Communication loss	PLC to LTM R	X	X	X
	HMI to LTM R	X	X	X

X Monitored
– Not monitored

Manual Reset

Introduction

When the Fault Reset Mode parameter is set to **Manual**, the LTM R controller allows resets–usually performed by a person–via a power cycle of the control power or by using a local reset means, including:

- Local Terminal Strip (logic input I.5)
- Reset button on the LTM R controller
- Reset commands from the local HMI

A manual reset provides on-site personnel the opportunity to inspect the equipment and wiring before performing the reset.

Note: A manual reset blocks all reset commands from the LTM R controller's network port—even when the Control Mode is set to **Network**.

Manual Reset Methods

The LTM R controller provides the following manual reset methods:

Protection Category	Monitored fault	Control mode		
		Local terminal strip	Local HMI	Network [1]
Diagnostic	Run Command Check	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Stop Command Check	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Run Check Back	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Stop Check Back	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
Wiring / configuration errors	PTC connection	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	CT Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Voltage Phase Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Current Phase Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Voltage Phase Loss	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Phase Configuration	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
Internal	Stack Overflow	PC	PC	PC
	Watchdog	PC	PC	PC
	ROM Checksum	PC	PC	PC
	EEROM	PC	PC	PC
	CPU	PC	PC	PC
	Internal Temperature	PC	PC	PC
Thermal resistance (motor temp sensor)	PTC Binary	RB, I.5	RB, I.5	RB, I.5
	PTC Analog	RB, I.5	RB, I.5	RB, I.5
	NTC Analog	RB, I.5	RB, I.5	RB, I.5
Thermal overload	Definite	RB, I.5	RB, I.5	RB, I.5
	Inverse Thermal	RB, I.5	RB, I.5	RB, I.5

RB Test/Reset button on the LTM R controller front face or a local HMI
PC Power cycle on the LTM R controller
I.5 Set I.5 logic input on the LTM R controller

1. Remote network reset commands are not allowed even when the LTM R controller is configured for network control mode.

Protection Category	Monitored fault	Control mode		
		Local terminal strip	Local HMI	Network [1]
Current	Long Start	RB, I.5	RB, I.5	RB, I.5
	Jam	RB, I.5	RB, I.5	RB, I.5
	Current Phase Imbalance	RB, I.5	RB, I.5	RB, I.5
	Current Phase Loss	RB, I.5	RB, I.5	RB, I.5
	Undercurrent	RB, I.5	RB, I.5	RB, I.5
	Overcurrent	RB, I.5	RB, I.5	RB, I.5
	External Ground Current	RB, I.5	RB, I.5	RB, I.5
	Internal Ground Current	RB, I.5	RB, I.5	RB, I.5
Voltage	Undervoltage	RB, I.5	RB, I.5	RB, I.5
	Overvoltage	RB, I.5	RB, I.5	RB, I.5
	Voltage Phase Imbalance	RB, I.5	RB, I.5	RB, I.5
Power	Underpower	RB, I.5	RB, I.5	RB, I.5
	Overpower	RB, I.5	RB, I.5	RB, I.5
	Under Power Factor	RB, I.5	RB, I.5	RB, I.5
	Over Power Factor	RB, I.5	RB, I.5	RB, I.5
Communication loss	PLC to LTM R	RB, I.5	RB, I.5	RB, I.5
	LTM E to LTM R	RB, I.5	RB, I.5	RB, I.5

RB Test/Reset button on the LTM R controller front face or a local HMI
PC Power cycle on the LTM R controller
I.5 Set I.5 logic input on the LTM R controller

1. Remote network reset commands are not allowed even when the LTM R controller is configured for network control mode.

Automatic Reset

Introduction

Setting the Fault Reset Mode parameter to **Automatic** lets you:

- configure the LTM R controller to attempt to reset motor protection and communications faults without the intervention of either a human operator or the remote PLC, for example:
  - for a non-networked LTM R controller installed at a location that is physically remote, or locally hard to access
- configure fault handling for each protection fault group in a manner that is appropriate to the faults in that group:
  - set a different timeout delay
  - permit a different number of reset attempts
  - disable automatic fault resetting

The Control Mode parameter selection determines the available reset methods.

Each protection fault is included in 1 of 3 auto-reset fault groups, based on the characteristics of that fault, as described below. Each fault group has two configurable parameters:

- a timeout: the Auto-Reset Group (number 1, 2, or 3) Timeout parameter, and
- a maximum number of permissible fault resets: the Auto-Reset Attempts Group (number 1, 2, or 3) Setting parameter

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

An auto-reset command may restart the motor if the LTM R controller is used in a 2-wire control circuit.

Equipment operation must conform to local and national safety regulations and codes.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

Reset Behavior

After power is cycled, the LTM R controller clears and sets to 0 the values of the following parameters:

- Auto-Reset Group number (1, 2, or 3) Timeout and
- Auto Reset Group number (1, 2, or 3) Setting.

On a successful reset, the Number of Resets count is cleared and set to 0. A reset is successful if, after reset, the motor runs for 1 minute without a fault of a type in the designated group.

Emergency Restart

Use the Clear Thermal Capacity Level Command–in applications where it is necessary–to clear the Thermal Capacity Level parameter following a Thermal Overload inverse thermal fault. This command permits an emergency restart before the motor has actually cooled. It also clears and sets to 0 auto-restart group timeout and number of auto-resets statistics.

⚠ WARNING

LOSS OF MOTOR PROTECTION

Clearing the thermal capacity level inhibits thermal protection and can cause equipment overheating and fire. Continued operation with inhibited thermal protection must be limited to applications where immediate restart is vital.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

Number of Resets

Each protection group can be set to manual, 1, 2, 3, 4 or unlimited automatic reset attempts.

Select "0" to disable automatic reset of protection fault groups—and require a manual reset—even though the Fault Reset Mode parameter is configured for automatic reset.

Select "A" to enable a unlimited auto-reset attempts. After the time delay has expired the LTM R controller continually attempts to reset every fault in that reset group.

Auto-Reset Group 1

Group 1 faults require a pre-defined cooling time after the monitored parameter returns to and falls below a pre-defined threshold. Group 1 faults include Thermal Overload and Motor Temp Sensor faults. The cooling time delay is non-configurable. However, you can:

- add to the cooling time delay by setting the Auto-Reset Group 1 Timeout parameter to a value greater than 0, or
- disable auto-reset by setting the Auto-Reset Group 1 Timeout parameter to 0

Auto-reset group 1 has the following configurable parameters:

Parameters	Setting range	Factory setting
Auto-Reset Attempts Group 1 Setting	0=manual, 1, 2, 3, 4, A=unlimited number of reset attempts	A
Auto-Reset Group 1 Timeout	0...65535 s	480 s

Auto-Reset Group 2

Group 2 faults generally do not include a pre-defined cooling time delay before a reset can be executed, but can be reset as soon as the fault condition clears. Many group 2 faults can result in some motor overheating, depending upon the severity and duration of the fault condition, which in turn depends upon the protection function configuration.

You can add a cooling time delay, if appropriate, by setting the Auto-Reset Group 2 Timeout parameter to a value greater than 0. You may also want to limit the number of reset attempts to prevent premature wear or failure of the equipment.

Auto-reset group 2 has the following configurable parameters:

Parameters	Setting range	Factory setting
Auto-Reset Attempts Group 2 Setting	0=manual, 1, 2, 3, 4, A=unlimited number of reset attempts	0
Auto-Reset Group 2 Timeout	0...65535 s	1200 s

Auto-Reset Group 3

Group 3 faults often apply to equipment monitoring and generally do not require a motor cooling period. These faults can be used to detect equipment conditions–for example, an undercurrent fault that detects the loss of a belt, or an overpower fault that detects an increased loading condition in a mixer. You may want to configure group 3 faults in a way that differs significantly from gorups 1 or 2, for example by setting the number of resets to 0, thereby requiring a manual reset after the equipment failure has been discovered and corrected.

Auto-reset group 3 has the following configurable parameters:

Parameters	Setting range	Factory setting
Auto-Reset Attempts Group 3 Setting	0=manual, 1, 2, 3, 4, A=unlimited number of reset attempts	0
Auto-Reset Group 3 Timeout	0...65535 s	60 s

Auto-Reset Methods The LTM R controller allows the following auto-reset methods:

Protection category	Monitored fault	Control mode		
		Local terminal strip	**Local HMI**	**Network**
Diagnostic	Run Command Check	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
	Stop Command Check	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
	Run Check Back	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
	Stop Check Back	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
Wiring / configuration errors	PTC connection	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	CT Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Voltage Phase Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Current Phase Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Voltage Phase Loss	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Phase Configuration	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
Internal	Stack Overflow	PC	PC	PC
	Watchdog	PC	PC	PC
	ROM Checksum	PC	PC	PC
	EEROM	PC	PC	PC
	CPU	PC	PC	PC
	Internal Temperature	PC	PC	PC
Motor temp sensor	PTC Binary	AU-G1	AU-G1	AU-G1
	PTC Analog	AU-G1	AU-G1	AU-G1
	NTC Analog	AU-G1	AU-G1	AU-G1
Thermal overload	Definite	AU-G1	AU-G1	AU-G1
	Inverse Thermal	AU-G1	AU-G1	AU-G1

RB Test/Reset button on the LTM R controller front face or the local HMI
PC Power cycle on the LTM R controller
I.5 Set I.5 logic input on the LTM R controller
NC network command
AU-GX Automatic with conditions configured for the protection function group (Where GX = G1, G2, or G3)
G1 Fault AutoGroup 1 has a configurable number of resets (0 = manual, 1, 2, 3, 4, 5 = unlimited) and setting delay.
G2 Fault Auto Group 2 has a configurable number of resets (0 = manual, 1, 2, 3, 4, 5 = unlimited) and setting delay.
G3 Fault Auto Group 3 has a configurable number of resets (0 = manual, 1, 2, 3, 4, 5 = unlimited) and setting delay.

Protection category	Monitored fault	Control mode		
		Local terminal strip	**Local HMI**	**Network**
Current	Long Start	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Jam	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Current Phase Imbalance	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Current Phase Loss	RB, I.5	RB, I.5	RB, I.5, NC
	Undercurrent	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	Overcurrent	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	External Ground Current	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Internal Ground Current	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
Voltage	Undervoltage	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Overvoltage	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Voltage Phase Imbalance	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
Power	Underpower	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	Overpower	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	Under Power Factor	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Over Power Factor	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
Communication Loss	PLC to LTM R	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	LTM E to LTM R	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3

RB Test/Reset button on the LTM R controller front face or the local HMI
PC Power cycle on the LTM R controller
I.5 Set I.5 logic input on the LTM R controller
NC network command
AU-GX Automatic with conditions configured for the protection function group (Where GX = G1, G2, or G3)
G1 Fault AutoGroup 1 has a configurable number of resets (0 = manual, 1, 2, 3, 4, 5 = unlimited) and setting delay.
G2 Fault Auto Group 2 has a configurable number of resets (0 = manual, 1, 2, 3, 4, 5 = unlimited) and setting delay.
G3 Fault Auto Group 3 has a configurable number of resets (0 = manual, 1, 2, 3, 4, 5 = unlimited) and setting delay.

Remote Reset

Introduction

Setting the Fault Reset Mode parameter to **Remote** adds resetting faults from the PLC over the LTM R network port. This provides centralized monitoring and control of equipment installations. The Control Mode parameter selection determines the available reset methods.

Both manual reset methods and remote reset methods reset a fault.

Remote Reset Methods

The LTM R controller provides the following remote reset methods:

Protection Category	Monitored fault	Control mode		
		Local terminal strip	Local HMI	Network
Diagnostic	Run Command Check	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Stop Command Check	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Run Check Back	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Stop Check Back	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
Wiring / configuration errors	PTC connection	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	CT Reversal	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Voltage Phase Reversal	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Current Phase Reversal	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Voltage Phase Loss	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Phase Configuration	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
Internal	Stack Overflow	PC	PC	PC
	Watchdog	PC	PC	PC
	ROM Checksum	PC	PC	PC
	EEROM	PC	PC	PC
	CPU	PC	PC	PC
	Internal Temperature	PC	PC	PC
Motor temp sensor	PTC Binary	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	PTC Analog	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	NTC Analog	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC

RB Test/Reset button on the LTM R controller front face or the local HMI
PC Power cycle on the LTM R controller
I.5 Set I.5 logic input on the LTM R controller
NC Network command

Protection Category	Monitored fault	Control mode		
		Local terminal strip	**Local HMI**	**Network**
Thermal overload	Definite	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Inverse Thermal	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
Current	Long Start	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Jam	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Current Phase Imbalance	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Current Phase Loss	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Undercurrent	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Overcurrent	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	External Ground Current	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Internal Ground Current	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
Voltage	Undervoltage	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Overvoltage	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Voltage Phase Imbalance	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
Power	Underpower	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Overpower	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Under Power Factor	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Over Power Factor	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
Communication Loss	PLC to LTM R	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	LTM E to LTM R	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC

RB Test/Reset button on the LTM R controller front face or the local HMI
PC Power cycle on the LTM R controller
I.5 Set I.5 logic input on the LTM R controller
NC Network command

Fault and Warning Codes

The Fault Code parameter describes the type of fault or warning that most recently occurred. Each fault or warning type is represented by a number. The following table maps Fault Code values to fault and warning types:

Fault Code	Description	Fault	Warning
0	No fault or warning	X	X
3	Ground current	X	X
4	Thermal overload	X	X
5	Long start	X	X
6	Jam	X	X
7	Current phase imbalance	X	X
8	Undercurrent	X	X
10	Test	X	X
11	HMI port error	X	X
12	HMI port communication loss	X	X
13	Network port internal error	X	X
18	Diagnostic	X	X
19	Connection	X	X
20	Overcurrent	X	X
21	Current phase loss	X	X
22	Current phase reversal	X	X
23	Motor temperature sensor	X	X
24	Voltage phase imbalance	X	X
25	Voltage phase loss	X	X
26	Voltage phase reversal	X	X
27	Undervoltage	X	X
28	Overvoltage	X	X
29	Underpower	X	X
30	Overpower	X	X
31	Under power factor	X	X
32	Over power factor	X	X
33	Load shedding	X	–
X = Fault or Warning reported **– = Fault or Warning not reported**			

Fault Code	Description	Fault	Warning
51	Controller internal temperature error	X	–
55	Controller internal error (stack overflow)	X	–
56	Controller internal error (RAM error)	X	–
57	Controller internal error (ROM checksum error)	X	–
58	Controller internal error (Hardware watchdog fault)	X	–
59	Controller internal error	X	–
60	L2 current detected in 1-phase mode	X	–
64	EEROM error	X	–
65	Expansion module communication error	X	–
66	Stuck reset button	X	–
67	Logic function error	X	–
100	Network port internal error	X	–
101	Network port internal error	X	–
102	Network port internal error	X	–
104	Network port internal error	X	–
109	Network port communication error	X	–
555	Network port configuration error	X	–
X = Fault or Warning reported **– = Fault or Warning not reported**			

Installation

6

Introduction

Overview

This chapter describes the physical installation and assembly of the LTM R controller and the LTM E expansion module. It also explains how to connect and wire the controller terminal block, including communication port wiring.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Turn off all power supplying this equipment before working on it.
- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices.

Failure to follow this instruction will result in death or serious injury.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program and apply this product.
Follow all local and national safety codes and standards.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

What's in this Chapter?

This chapter contains the following sections:

Section	Topic	Page
6.1	LTM R Controller and LTM E Expansion Module Installation	271
6.2	Wiring of the Modbus® Communication Network	304

6.1 LTM R Controller and LTM E Expansion Module Installation

Installation Overview

Installation

This section describes the installation procedures and wiring principles of the LTM R controller and the LTM E expansion module.

What's in this Section?

This section contains the following topics:

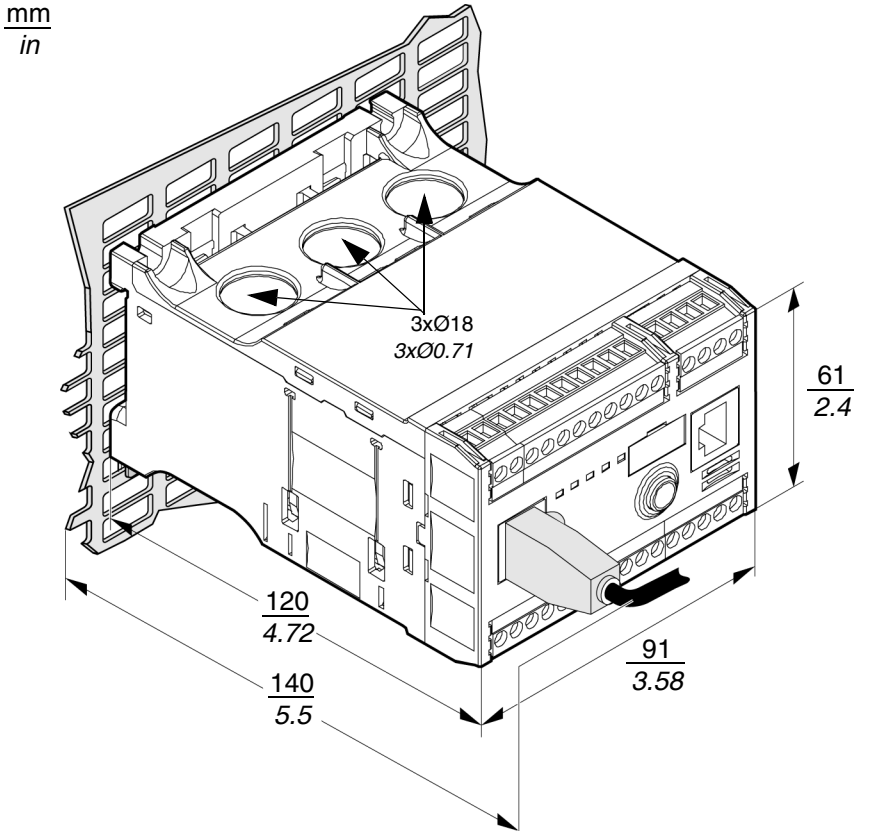
Topic	Page
LTM R Controller and Expansion Module Dimensions	272
Mounting the LTM R Controller and the Expansion Module	275
Assembling the LTM R Controller and the Expansion Module	280
Connecting to an HMI Device	283
Wiring - General Principles	287
Wiring - Current Transformers (CTs)	291
Wiring - Ground Fault Current Transformers	296
Wiring - Temperature Sensors	298
Recommended Contactors	299

LTM R Controller and Expansion Module Dimensions

Overview

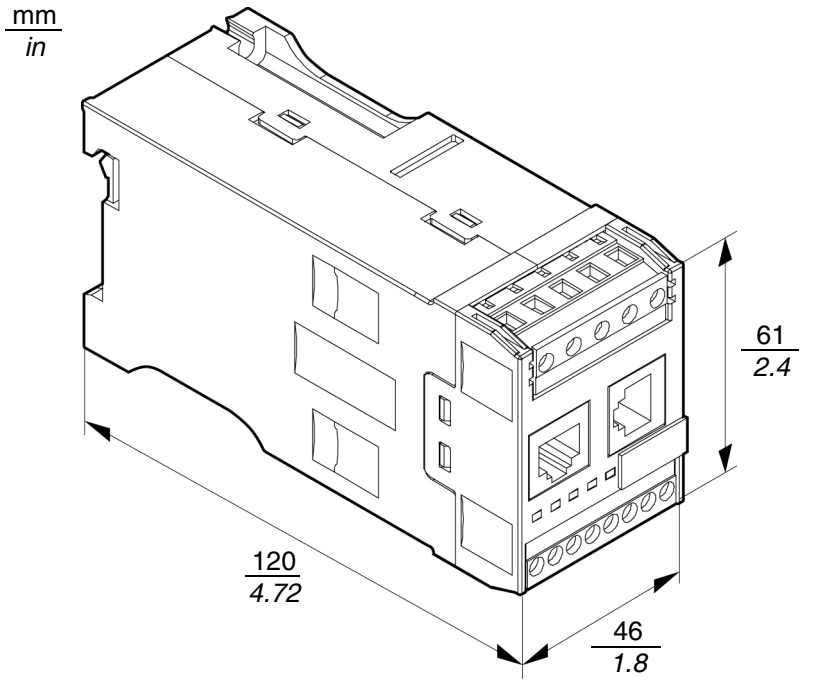
This section presents the dimensions of the LTM R controller and the LTM E expansion module, as well as the dimensions of the clearance zone around the controller and the expansion module. Dimensions are given in both millimeters and inches and apply to all LTM R and LTM E units.

LTM R Controller Dimensions



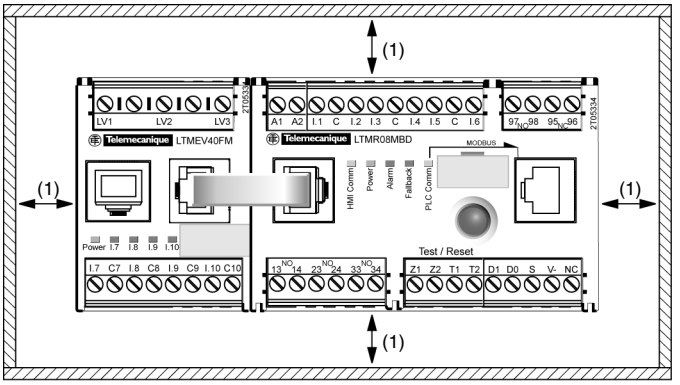
Note: The height of the controller may increase when using alternate wiring terminals.

Expansion Module Dimensions

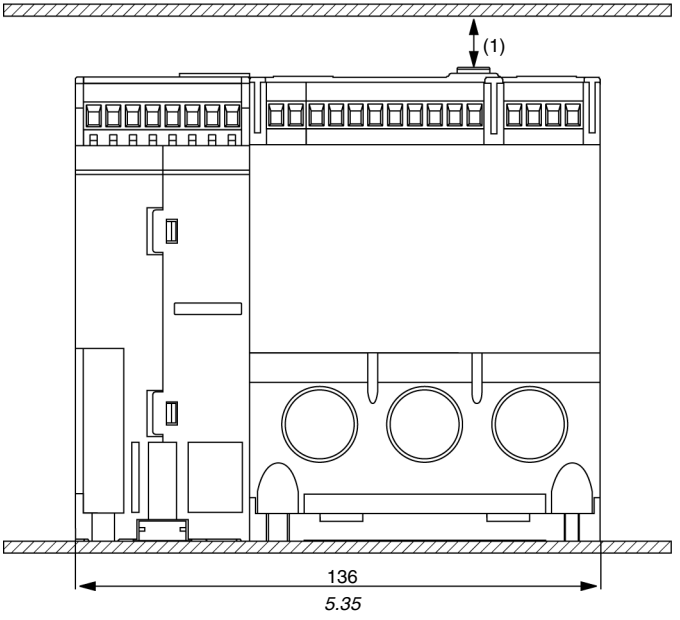


Clearance Zone Dimensions

The maximum rated ambient temperature of the controller depends on the clearance zone dimensions. They are shown in the table below.



(1)	< 9 mm (0.35 in)	45 °C *(113 °F)*
	9...40 mm (0.35...1.57 in)	45...55 °C *(113...131 °F)*
	> 40 mm (1.57 in)	60 °C *(140 °F)*



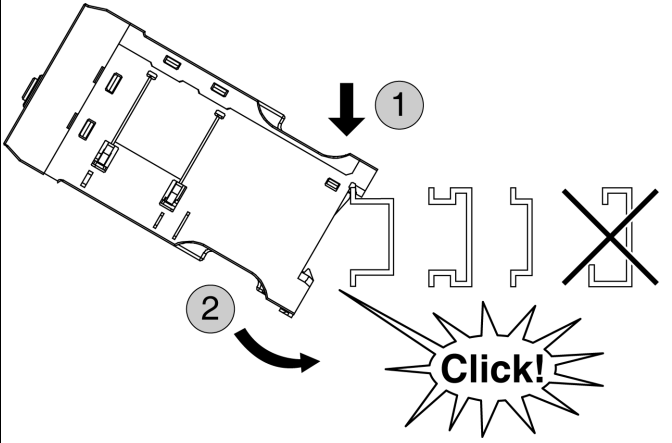
Mounting the LTM R Controller and the Expansion Module

Overview

This section describes how to mount the LTM R controller and the LTM E expansion module on a DIN rail, a solid mounting plate, or a pre-slotted mounting plate (known as a TE plate), such as a Telequick® plate. It also describes the accessories needed for mounting, as well as how to remove each component.

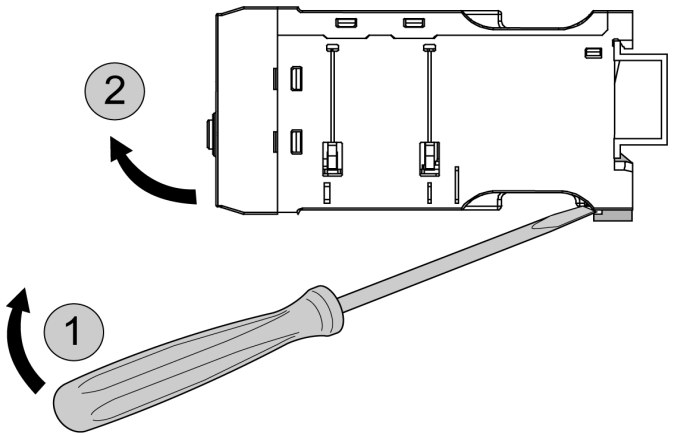
Mounting on DIN Rails

You can mount the controller and the expansion module on a 35 mm (1.38 in.) DIN rail with a thickness of 1.35 mm (0.05 in.)and 0.75 mm (0.02 in.). When mounted, the controller mounting feet may not extend beyond the controller dimensions (see *p. 272*).To mount the controller:

Step	Action
1	On the back of the controller are two DIN rail clips. Fit the top clip onto the DIN rail.
2	Push the controller in toward the DIN rail until the bottom clip catches. The controller clicks into place. 

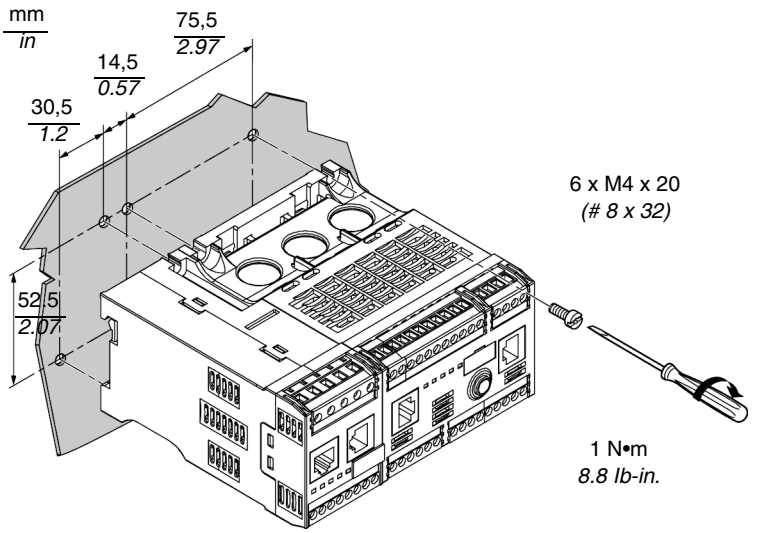
Removing from DIN Rails

To remove the controller from the DIN rail:

Step	Action
1	Using a screwdriver, pull down the white locking mechanism to release the controller.
2	Lift the controller away from the DIN rail. 

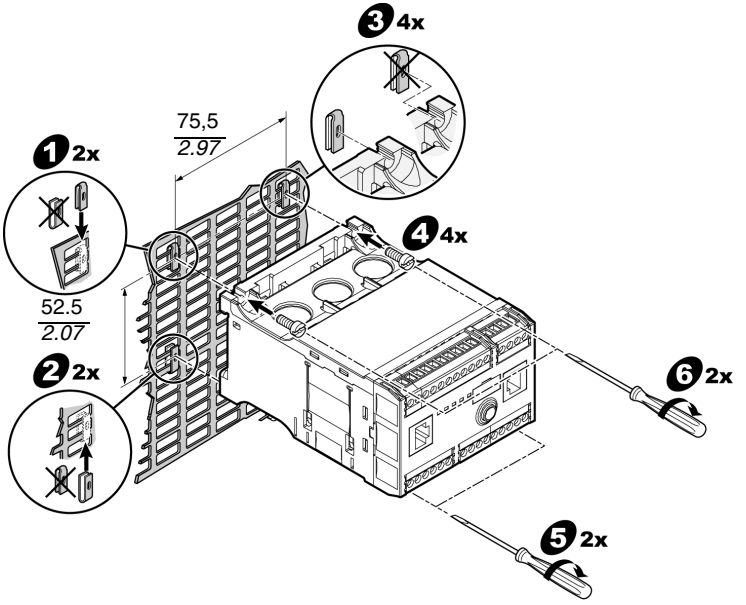
Mounting on a Solid Mounting Plate

You can mount the controller and the expansion module on a metal mounting plate using ST2.9 steel tapping screws: 4 for the controller and 2 for the expansion module. The thickness of the mounting plate must not exceed 7 mm (0.275 in.). When mounted, the controller mounting feet may extend beyond the controller dimensions (see *p. 272*) by 8 mm (0.3 in.) in both directions.To mount the controller and the expansion module on a mounting plate:

Step	Action
1	Locate the 4 mounting holes at each corner of the controller and the 2 mounting holes on the expansion module.
2	Position the controller and expansion module on the mounting plate, making sure to leave enough space for the clearance zone. See *p. 272*.
3	Insert each of the 6 tapping screws.
4	Use a screwdriver to tighten each screw and secure the controller and the expansion module in place. Torque to 1 N•m (8.8 lb-in). 

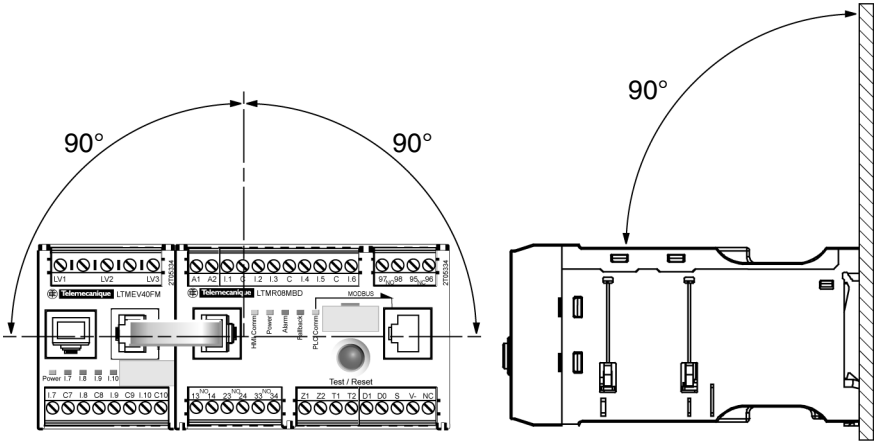
Mounting on a TE Plate

You can mount the controller and the expansion module on a TE plate, such as Telequick®, using 6 mounting clips (AF1 EA4). When mounted, the controller mounting feet may extend beyond the controller dimensions (see *p. 272*) by 8 mm (0.3 in.) in both directions. To mount the controller on Telequick®:

Step	Action
1	Attach the 6 mounting clips to Telequick®, as shown in the diagram below. The rounded edge should face upwards for the top clips, and downwards for the bottom clips.
2	Position the controller and expansion module on the clips so that the holes in the clips and the holes in the controller and expansion module align. Insert the screws in the holes and turn them slightly.
3	When the controller and expansion module are properly positioned, tighten first the bottom screws, then the top screws using a screwdriver. Torque to 1 N•m (8.8 lb-in). 

Operating Position

You can mount the controller and the expansion module at an angle of up to 90 degrees perpendicular to the normal vertical mounting plane.



Assembling the LTM R Controller and the Expansion Module

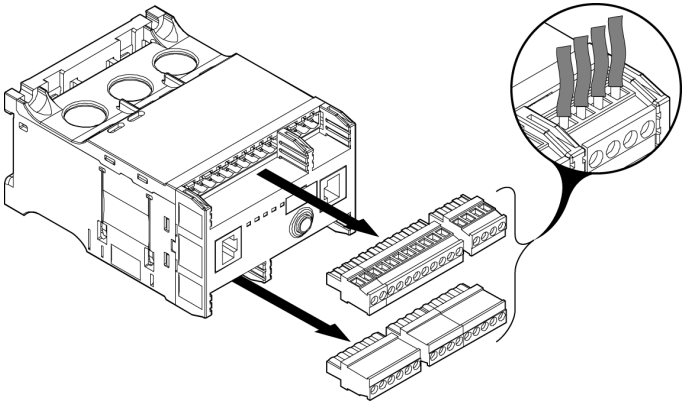
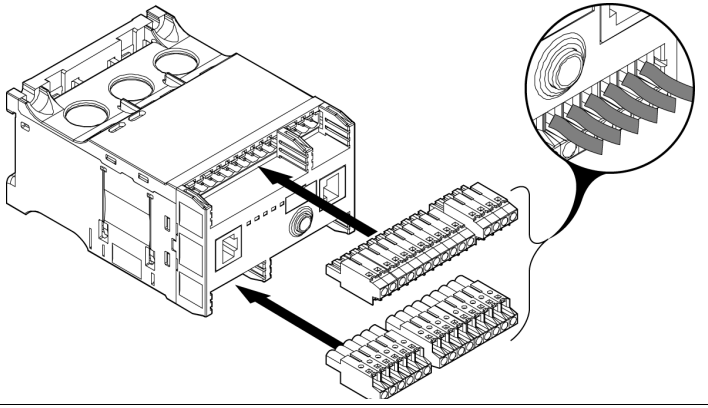
At a Glance

Once you have mounted the LTM R controller - and the expansion module, if required - you must assemble the different parts of the system. This section describes how to connect the controller with the expansion module, as well as how to replace the standard terminal strips with alternative terminal strips.

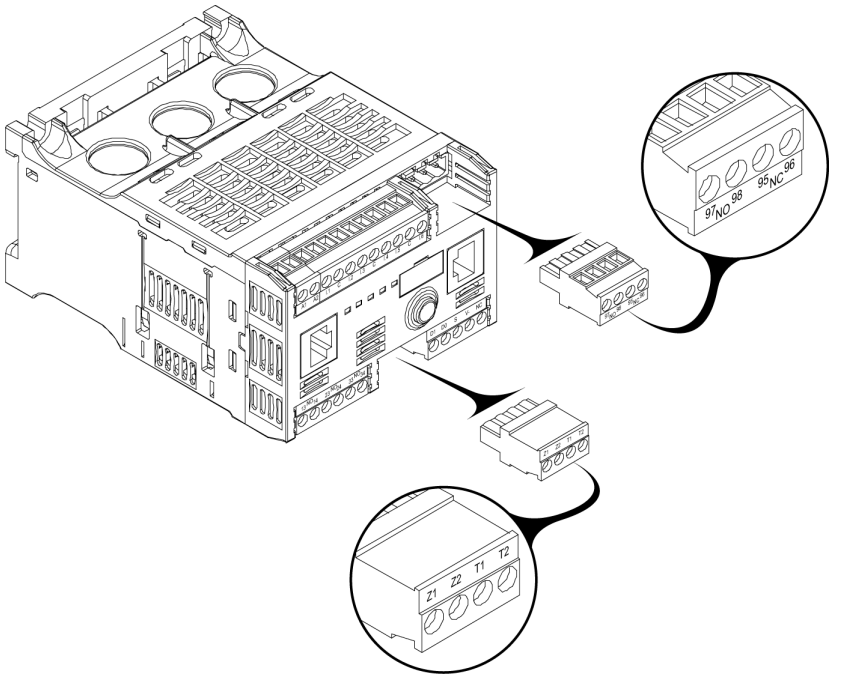
Replacing the Terminal Strips

The standard terminal strips of the controller and expansion module can be replaced with alternative terminal strips, if required. With alternative terminal strips, wires are connected perpendicularly to the controller or expansion module face.

To replace the standard strips with alternative strips:

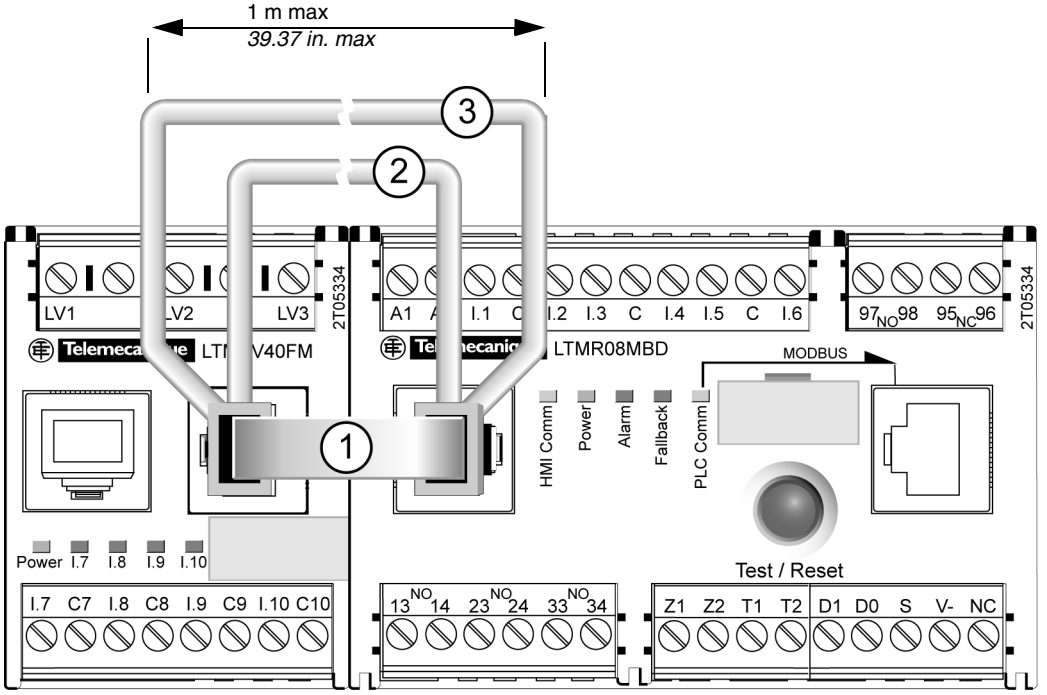
Step	Action
1.	Remove the 6 standard terminal strips using a screwdriver to leverage the strips away from the unit. 
2.	Push the alternative strips into place, making sure you position them correctly. 

Note: There are two 4-pin terminal strips. These strips are not interchangeable. It is important, therefore, that you read the markings on the terminal strips and follow the diagram below when positioning them.



Connecting the LTM R Controller and the Expansion Module

The LTM R controller connects to the expansion module using an RJ45 network connection cable, as shown in the diagram below.



Three lengths of cable are available to connect the controller and the expansion module, depending on their relative positions. These cables, which are terminated at each end with an RJ45 connector, are described in the table below.

	Cable Reference	**Length**
1	LTMCC004	40 mm (1.57 in.)
2	LU9R03	0.3 m (11.81 in.)
3	LU9R10	1 m (39.37 in.)

Connecting to an HMI Device

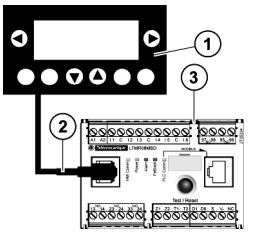
Overview

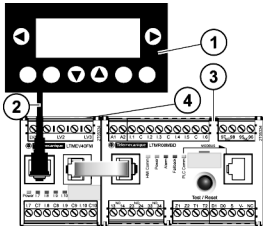
This section describes how to connect the LTM R controller to an HMI device, such as a Magelis® XBT or a PC running PowerSuite™ software. The HMI must be connected to the RJ45 port on the LTM R controller, or to the HMI interface port (RJ45) on the expansion module.

You can connect an HMI to a controller in 1-to-1 or 1-to-many mode.

Connecting to a Magelis® XBT HMI Device in 1-to-1 Mode

The diagrams below show the Magelis® XBTN410 HMI connected to the controller, with and without the expansion module:

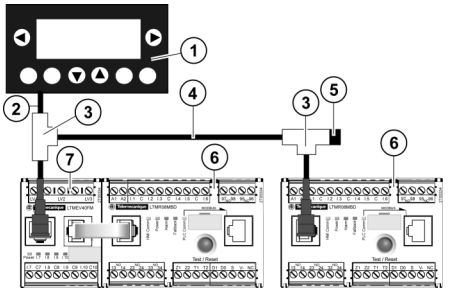




1 Magelis® XBTN410 HMI device
2 Magelis® connecting cable XBTZ938
3 LTM R controller
4 Expansion module

Connecting to a Magelis® XBT HMI Device in 1-to-Many Mode

The diagram below shows a 1-to-many connection from the Magelis® XBTN410 HMI to up to 8 controllers (with or without the expansion module):



1 Magelis® XBTN410 HMI device
2 Magelis® connecting cable XBTZ938
3 T-junction boxes VW3 A8 306 TF••
4 Communication cable VW3 A83 06R••
5 Line terminators VW3 A8 306 R
6 LTM R controller
7 Expansion module

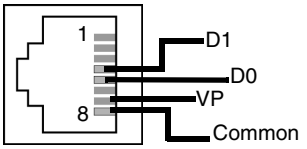
Note: For a full list of connection accessories, see *p. 286*.

Connecting to a Generic HMI Device

You can also connect the LTM R controller and the expansion module to an HMI device of your choice, using a customized cable.

The customized cable requires the following RJ45 port pinouts to connect to the LTM R controller or the expansion module:

Front view

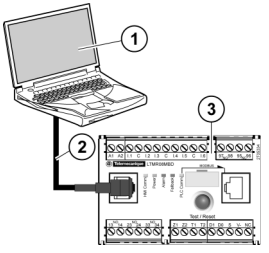


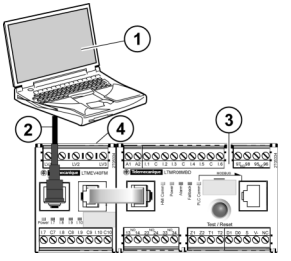
The RJ45 wiring layout is:

Pin no.	Signal	Description
1	Do not connect	LTM R (or LTM E) transceiver
2	Do not connect	LTM R (or LTM E) transceiver
4	D1 or D(B)	Communication between HMI and LTM R controller
5	D0 or D(A)	Communication between HMI and LTM R controller
6	Do not connect	LTM R (or LTM E) voltage zero crossing
7	VP	Positive 7 Vdc power supply
8	Common	Signal and power supply common

Connecting to a PC running PowerSuite™ Software in 1-to-1 Mode

The diagrams below show a 1-to-1 connection from a PC running PowerSuite™ to the LTM R controller, with and without the expansion module:

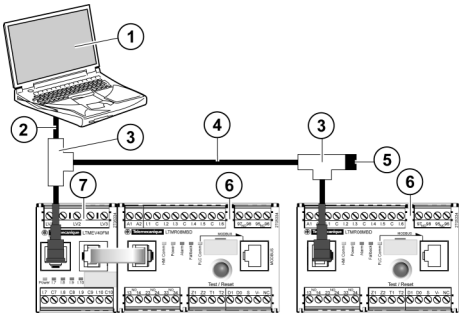




1 PC running PowerSuite™ software
2 Power cable VW3 A8 106
3 LTM R controller
4 Expansion module

Connecting to a PC running PowerSuite™ Software in 1-to-Many Mode

The diagram below shows a 1-to-many connection from a PC running PowerSuite™ software to up to 8 controllers (with or without the expansion module):



1 PC running PowerSuite™ software
2 Power cable VW3 A8 106
3 T-junction boxes VW3 A8 306 TF••
4 Communication cable VW3 A83 06R••
5 line terminators VW3 A8 306 R
6 LTM R controller
7 Expansion module

Connection Accessories

The following table lists connection accessories for the Magelis® XBT and other HMI devices:

Designation	Description	Reference
T-junction boxes	With 0.3 m (1 ft) integrated cable	VW3 A8 306 TF03
	With 1 m (3.2 ft) integrated cable	VW3 A8 306 TF10
Line terminators for RJ45 connector	R = 150 Ω	VW3 A8 306 R
Magelis® connecting cable (Magelis® XBTN410 only)	Length = 2.5 m (8.2 ft) 25 pts SUB-D connector to connect to Magelis® XBT	XBTZ938
Power cable (PC only)	Length = 1 m (3.2 ft) RS-232 to RS-485 converter	VW3A8106
Communication cables	Length = 0.3 m (1 ft)	VW3 A8 306 R03
	Length = 1 m (3.2 ft)	VW3 A8 306 R10

Wiring - General Principles

At a Glance

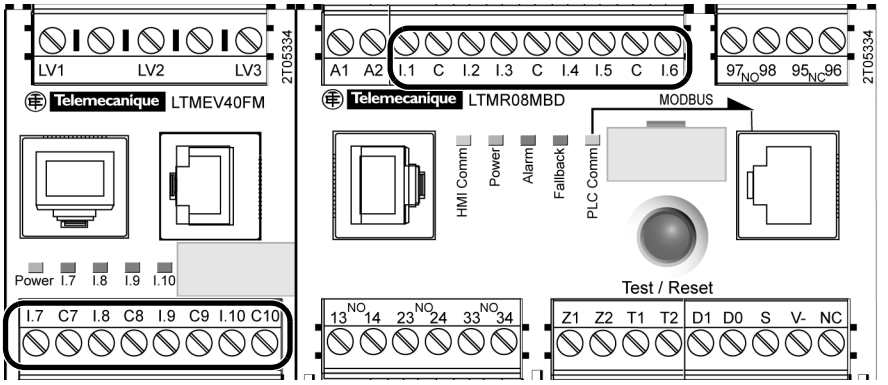
There are six stages in wiring the LTM R controller:

- Wiring the current transformers. See *p. 291*.
- Wiring the ground fault current transformers. See *p. 296*.
- Wiring the temperature sensors. See *p. 298*.
- Wiring the power supply and I/O. See *Inputs Wiring*, below, and *p. 38*.
- Wiring the voltage transformers and I/O on the Expansion Module. See *Inputs Wiring*, below, and *p. 38*.
- Wiring the communication port. See *p. 304*.

Inputs Wiring

The controller has 6 digital inputs available via field wiring terminals I.1- I.6. The input voltage is the same voltage as the controller supply voltage: the controller logic inputs are internally powered by the control voltage of the controller. Controller inputs are isolated from the inputs of the expansion module.

The 3 controller terminals for common wiring are not connected to the common of the LTM R, but are internally connected to the A1 control voltage terminal (see *p. 289*).



The 4 digital inputs on the expansion module (I.7 - I.10) are not powered by the control voltage of the controller. They are externally powered, and the inputs voltage depends on the expansion module model (24 Vdc, 110 Vac or 220 Vac).

Note: Because the expansion module is powered by the controller, it doesn't have a separate control voltage.

For more information on input characteristics, see *p. 38*.

Terminal Wiring Characteristics

Both the Controller and Expansion Module terminals have the same characteristics. Terminals have an insulation rating of 250 Vac.

The table below describes the characteristics of cables that may be used to wire the terminals:

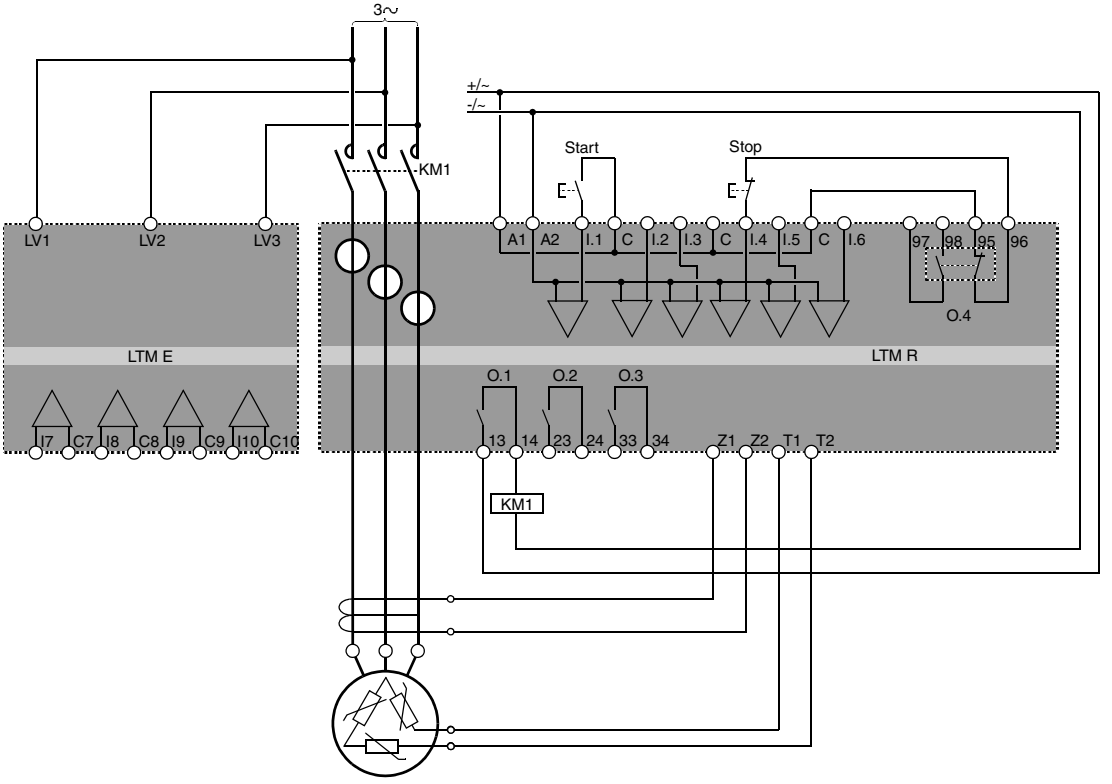
Cable Type	**No. of Conductors**	**Conductor section**	
		mm^2	**AWG**
Flexible (stranded) cable	Single conductor	0.2...2.5	24...14
	Two conductors	0.2...1.5	24...16
Solid cable	Single conductor	0.2...2.5	24...14
	Two conductors	0.2...1.0	24...18
Flexible (stranded) cable with insulated cable ends	Single conductor	0.25...2.5	24...14
	Two conductors	0.5...1.5	20...16
Flexible (stranded) cable with non-insulated cable ends	Single conductor	0.25...2.5	24...14
	Two conductors	0.2...1.0	24...18

The following table describes connector details:

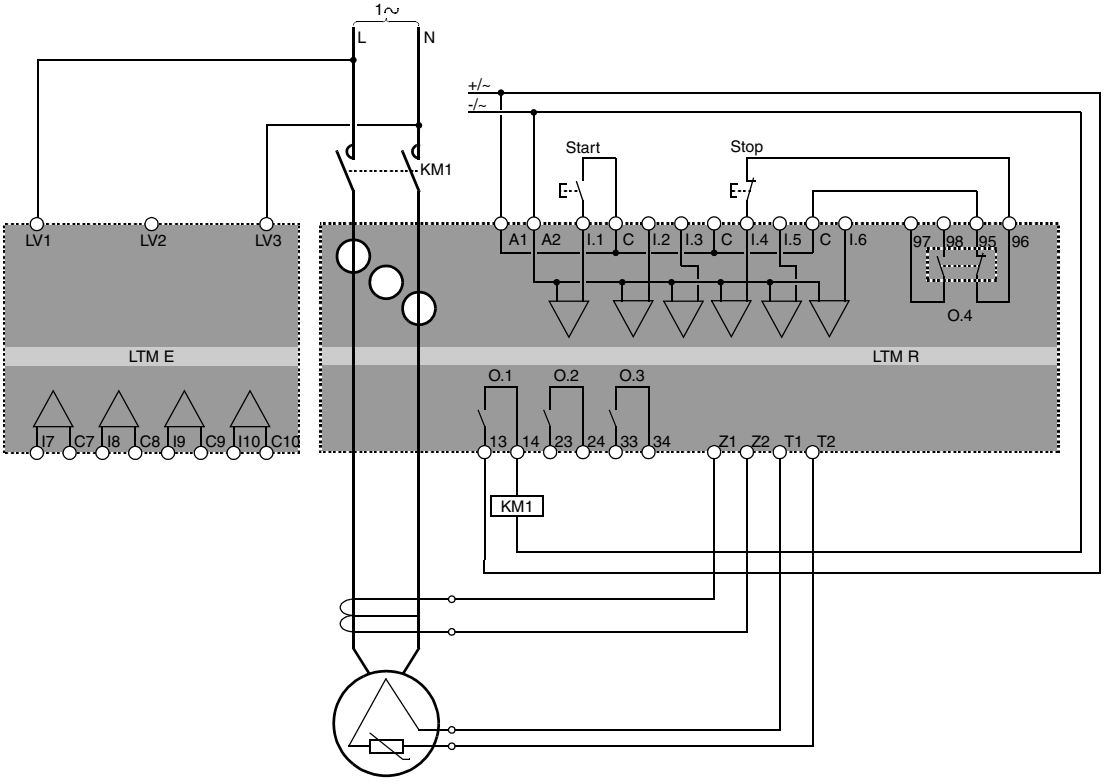
Connectors	3 and 6 pins	
Pitch	5.08 mm	0.2 in.
Tightening torque	0.5 to 0.6 N•m	5 lb-in
Flat screwdriver	3 mm	0.10 in.

Wiring Diagram Example

The following diagram shows the connections between the power supply and the I/Os in the terminal block when the controller is in 3-wire (impulse) independent mode:



The following diagram shows connections when the controller is in single-phase independent mode:



For more application diagrams, see *p. 509*.

Wiring - Current Transformers (CTs)

Overview

The LTM R controller has 3 CT windows through which you can route motor leads to contactor load connections.

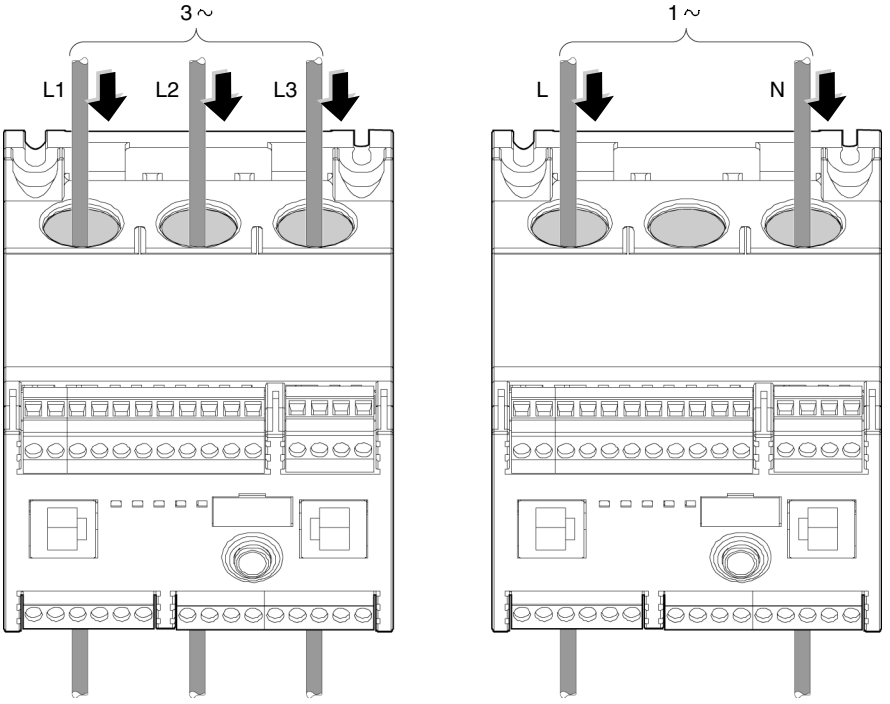
The CT windows enable you to wire the controller in four different ways, depending on the voltage and controller model used:

- Internal CT wiring through the windows.
- Internal CT wiring using multiple passes.
- Internal CT wiring using the lug kit (ref. Class 9999 MLPL).
- External Load CT wiring.

This section describes each of these options.

Internal CT Wiring through the Windows

Typical wiring using the CT windows for either three-phase or single-phase motors:

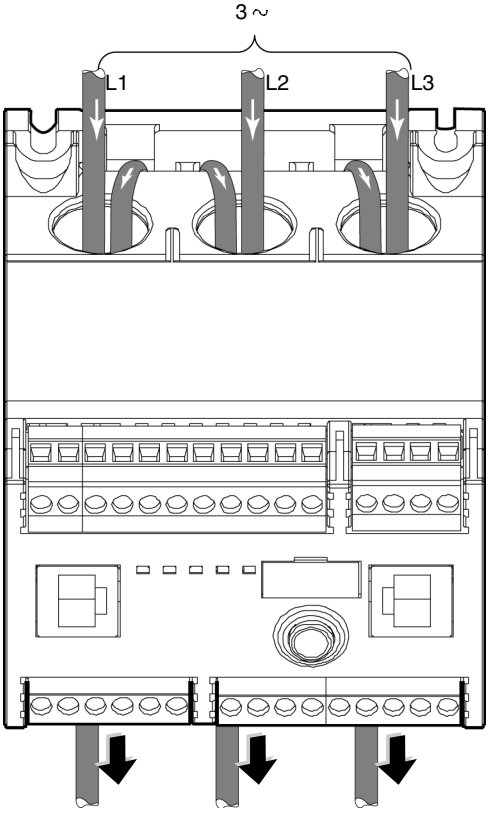


Internal CT Wiring Using Multiple Passes

The controller will physically support up to a maximum of 5 passes of 2.5 mm^2 (14 AWG) wire through the CT windows. There are three looping windows located under the CT windows that physically support up to a maximum of 4 wire loops.

You can set the parameter Load CT Multiple Passes to account for the number of times the motor wires pass through the CT window in order to display the correct current readings. For more information, see *p. 325*.

Typical wiring using 2 passes (1 wire loop):



Multiply the current by the number of times that the motor wires pass through the CT windows to determine the amount of current passing through the internal current sensors.

You may add multiple passes for one of the following reasons:

- To increase the current sensed by the internal current sensors to a level that the controller can properly detect
- To provide a more accurate reading by the internal current sensors

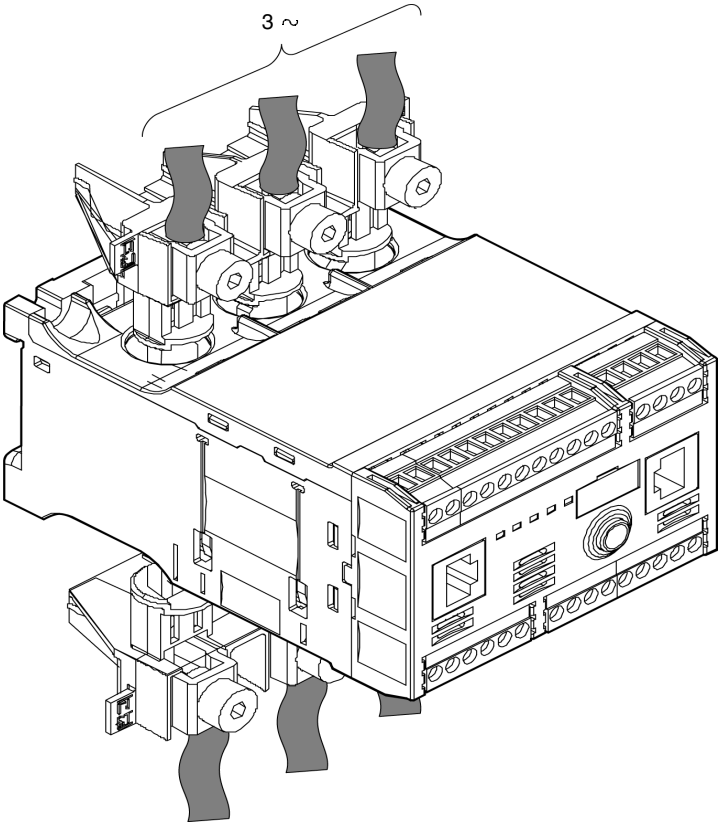
We recommend that you select a controller with an FLC value range that includes the motor FLC. However, if the motor FLC is less than the FLC range of the controller, multiple passes can increase the current level sensed by the internal current sensors to one that the controller can detect. For example, if you use a controller with an FLC range of 5 to 100 A, and the motor FLC is 3 A, the controller cannot properly sense the current. In this case, if you pass the power wiring through the internal current sensors of the controller 2 times, the internal current sensors of the controller sense 6 A (2 passes x 3 A), a current level that falls within the FLC range of the controller.

For more information about controller types, see *p. 19*.

Internal CT Wiring using a Lug-Lug kit

The controller accepts the Class 9999 Type MLPL lug-lug kit.

Typical wiring using the lug-lug kit:



Note: The lug-lug kit is IP0.

For more information on the lug-lug kit, refer to instruction bulletin 30072-013-101 supplied with the kit or available from www.us.SquareD.com (under Technical Library).

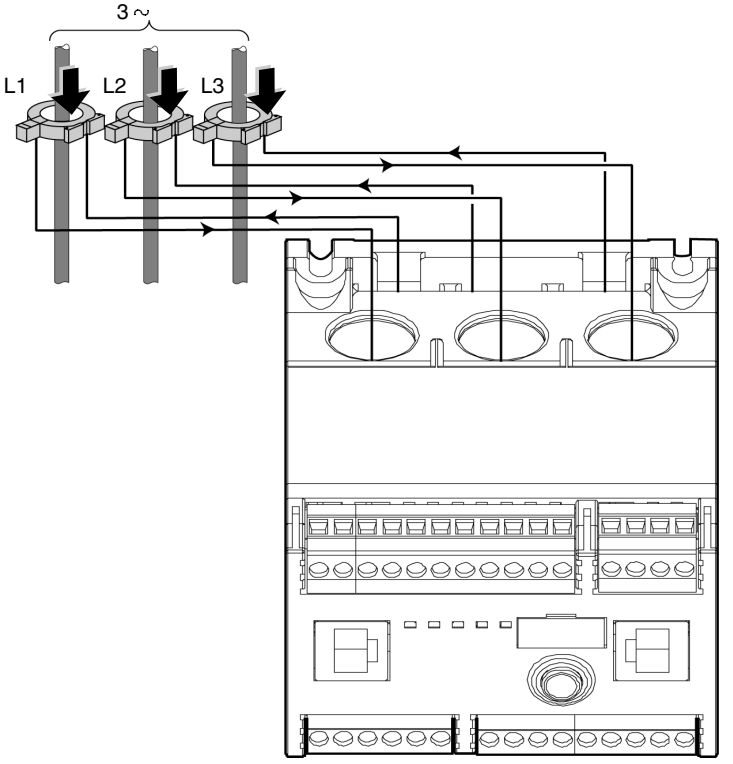
External Load CT Wiring

The controller can accept 5A and 1A secondary signals from external current transformers. The recommended controller model for these currents is the 0.4-8A model. You can also use multiple passes through the controller CT windows, if required.

External CTs are specified with a transformation ratio. The ratio of the external CT is the ratio of the motor input current to the CT output current.

Set the parameters Load CT Primary (the first number of the CT ratio), Load CT Secondary (the second number of the CT ratio), and Load CT Multiple Passes (the number of times the CT output wires pass through the controller's internal CT windows) to enable the controller to adjust the FLC range and display the actual line current. For more information, see *p. 325*.

Typical wiring using external CTs:



Note: The controller measures current at 47-63 Hz fundamental frequency. Therefore, if the controller is used with a variable speed drive, the controller must be installed between the drive and the line. The CTs cannot be used between the drive outputs and the motor since the drive can output fundamental frequencies outside the 47-63 Hz range.

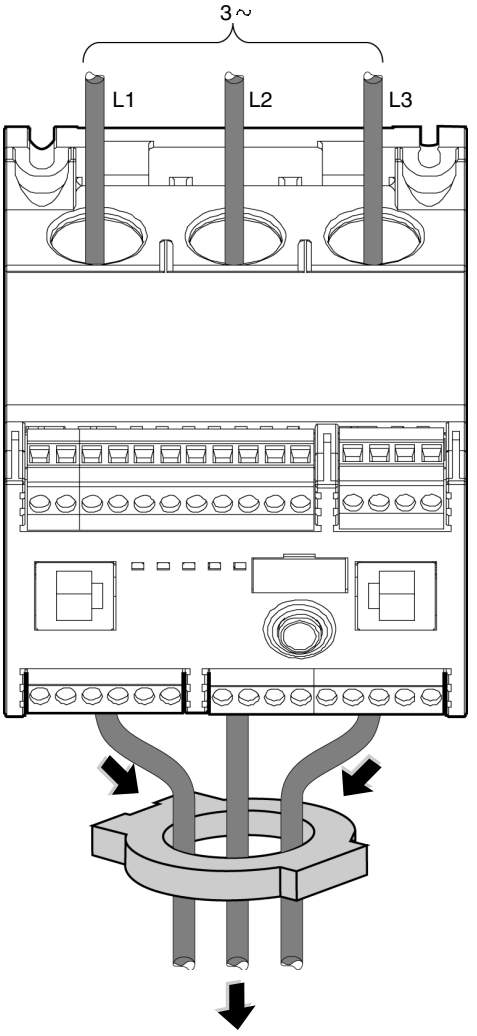
For a description of external CT characteristics, see *p. 21*.

Wiring - Ground Fault Current Transformers

Ground Fault Current Transformer Wiring

The LTM R controller has 2 terminals that can be connected to an external ground fault current transformer (GFCT): Z1 and Z2.

The following diagram shows typical wiring using a GFCT:



Note: You must wire the ground fault current transformer **before** wiring the power supply.

GFCTs are specified with a transformation ratio. The ratio of the GFCT is the ratio of the ground fault current sensed to the current which it outputs.

Set the parameters Ground CT Primary (the first number of the GFCT ratio) and Ground CT Secondary (the second number of the GFCT ratio) to enable the controller to correctly measure the actual ground fault current flowing in the circuit. For more information, see *p. 317*.

For a description of GFCT characteristics, see *p. 21*.

Wiring - Temperature Sensors

Temperature Sensors

The LTM R controller has 2 terminals dedicated to temperature sensing protection: T1 and T2. These terminals return the temperature value measured by resistance temperature detectors (RTDs).

One of the following types of motor temperature sensor can be used:

- PTC Binary
- PTC Analog
- NTC Analog

This function applies to both single-phase and 3-phase motors.

The following table shows the maximum wire lengths for temperature sensor elements:

mm^2 (AWG)	0.5 (20)	0.75 (18)	1.5 (16)	2.5 (14)
m (ft)	220 (656)	300 (985)	400 (1312)	600 (1970)

Use twisted pair wiring to connect the Controller to the temperature sensor. For the Controller to accurately measure the resistance of the temperature-sensing element, you must measure the resistance of the twisted-pair and add it to the desired resistance for protection. This compensates for the lead resistance.

See *Metering and Monitoring Functions, p. 59* and *Motor Protection Functions, p. 115* for more information on temperature sensors.

See *p. 287* for an example of a wiring diagram using a temperature sensor.

Recommended Contactors

Recommended Contactors

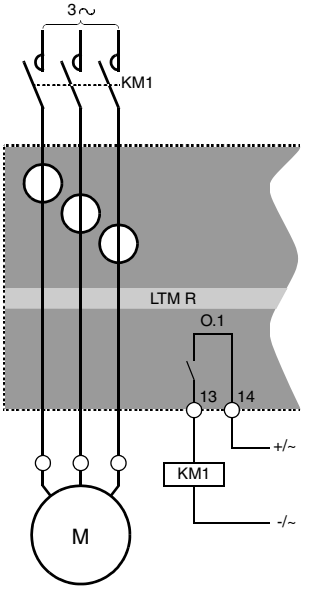
You can use the following contactor types:

- Telemecanique IEC-style contactors, from the TeSys® D or TeSys® F ranges
- Square D NEMA-style contactors, from the S range

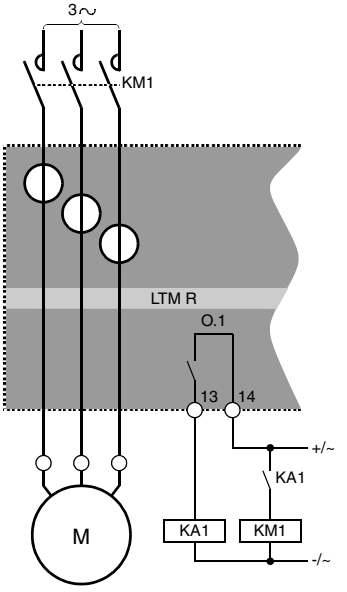
Interposing Relays

Depending on the coil voltage of the contactor used, an interposing relay may be required. The tables on the following pages, listing the references and characteristics of contactors, specify whether an interposing relay is required.

The following diagrams illustrate system wiring **without** and **with** the use of an interposing relay:



Without interposing relay



With interposing relay

TeSys® D and TeSys® F IEC Contactors

Catalog references and characteristics for TeSys® D IEC contactors are listed in the table below. Coil voltages are grouped according to whether an interposing relay is required:

TeSys® D catalog references	Control Circuit Frequency (Hz)	VA or W maintained (max)	Coil voltages	
			interposing relay not required	interposing relay required
LC1D09..LC1D38	50-60	7.5	AC = 24, 32, 36, 42, 48, 60, 100, 127, 200, 208, 220, 230, 240	AC = 277, 380, 400, 415, 440, 480, 575, 600, 690
		6	DC (std) = 24	DC (std) = 36, 48, 60, 72, 96, 100, 110, 125, 155, 220, 250, 440, 575
		2.4	DC (low consumption) = 24	DC (low consumption) = 48, 72, 96, 110, 220, 250
LC1D40..LC1D95		26	AC = 24, 32, 42, 48, 110, 115, 120, 127, 208, 220, 220/230, 230, 240	AC = 256, 277, 380, 380/400, 400, 415, 440, 480, 500, 575, 600, 660
		22		DC = 24, 36, 48, 60, 72, 110, 125, 220, 250, 440
LC1D115		18	AC = 24, 32, 42, 48, 110, 115, 120, 127, 208, 220, 230, 240	AC = 277, 380, 400, 415, 440, 480, 500
		22		DC = 24, 48, 60, 72, 110, 125, 220, 250, 440
LC1D150		18	AC = 24, 32, 42, 48, 110, 115, 120, 127, 208, 220, 230, 240	AC = 277, 380, 400, 415, 440, 480, 500
		5		DC = 24, 48, 60, 72, 110, 125, 220, 250, 440

Catalog references and characteristics for TeSys® F IEC contactors are listed in the table below. Coil voltages are grouped according to whether an interposing relay is required:

TeSys® F catalog references	Control Circuit Frequency (Hz)	VA or W maintained (max)	Coil voltages	
			interposing relay not required	interposing relay required
LC1F115	50	45	AC = 24, 42, 48, 110/115, 127, 220/230, 240	AC = 380/400, 415/440, 500, 660, 1000
	60	45	AC = 24, 42, 48, 110/115, 127, 220/230, 240, 265/277, 380, 415, 460/480, 660, 1000	
		5		DC = 24, 48, 110, 125, 220/230, 250, 440/460
LC1F150	50	45	AC = 24, 42, 48, 110/115, 127, 220/230, 240	AC = 380/400, 415/440, 500, 660, 1000
	60	45	AC = 24, 42, 48, 110/115, 127, 220/230, 240, 265/277, 380, 415, 460/480, 660, 1000	
		5		DC = 24, 48, 110, 125, 220/230, 250, 440/460
LC1F185*	50	55	AC = 24, 42, 48, 110/115, 127, 220/230, 240	AC = 380/400, 415/440, 500, 660, 1000
	60	55	AC = 24, 42, 48, 110/115, 127, 220/230, 240, 265/277, 380, 415, 460/480, 660, 1000	
		5		DC = 24, 48, 110, 125, 220/230, 250, 440/460
LC1F225*	50	55	AC = 24, 42, 48, 110/115, 127, 220/230, 240	AC = 380/400, 415/440, 500, 660, 1000
	60	55	AC = 24, 42, 48, 110/115, 127, 220/230, 240	AC = 265/277, 380, 415, 460/480, 660, 1000
		5		DC = 24, 48, 110, 125, 220/230, 250, 440/460

TeSys® F catalog references	Control Circuit Frequency (Hz)	VA or W maintained (max)	Coil voltages	
			interposing relay not required	interposing relay required
LC1F265	40..400**	10	AC = 24, 42, 48, 110/115, 127, 220/230, 240	AC = 277, 380/415, 480/500, 600/660, 1000
		5	DC = 24	DC = 48, 110, 125, 220/230, 250, 440/460
LC1F330		10	AC = 24, 42, 48, 110/115, 127, 220/230, 240	AC = 277, 380/415, 480/500, 600/660, 1000
		5	DC = 24	DC = 48, 110, 125, 220/230, 250, 440/460
LC1F400		15	AC = 48, 110/120, 125, 127, 200/208, 220/230, 230/240	AC = 265, 277, 380/400, 415/480, 500, 550/600, 1000
		8		DC = 48, 110, 125, 220, 250, 440
LC1F500		18	AC = 48, 110/120, 127, 200/208, 220/230, 230/240, 265, 277, 380/400, 415/480, 500, 550/600, 1000	
		8		DC = 48, 110, 125, 220, 250, 440
LC1F630		22	AC = 48, 110/120, 125, 127, 200/208, 220/240	AC = 265/277, 380/400, 415/480, 500, 550/600, 1000
		73		DC = 48, 110, 125, 220, 250, 440
LC1F780*		50	AC = 110/120, 127, 200/208, 220/240	AC = 265/277, 380, 415/480, 500
		52		DC = 110, 125, 220, 250, 440
LC1F800		15	AC = 110/127, 220/240	AC = 380/440
		25		DC =110/127, 220/240, 380/440

* Dual-parallel contactors of this size require an interposing relay.

** Control circuit frequency may be 40-400Hz; but power to contactors, monitored by CTs, must be 50Hz or 60Hz in frequency.

NEMA Type S Contactors

Catalog references and characteristics for NEMA Type S contactors are listed in the table below. Coil voltages are grouped according to whether an interposing relay is required:

NEMA size	VA maintained (max)	Control Circuit Frequency (Hz)	Coil voltages	
			interposing relay not required	interposing relay required
00	33	50/60	24, 115, 120, 208, 220, 240	277, 380, 440, 480, 550, 600
00, 0,1	27			
2	37			
	38			
3	47			
	89		115, 120, 208, 220, 240	277, 380, 440, 480, 550, 600
4				
5	15		115, 120, 208, 220, 240	277, 380, 440, 480
6	59		115, 120, 208, 220, 240	277, 380, 440, 480, 550, 600
7				

* Dual-parallel contactors of this size require an interposing relay.

The minimum load for these outputs is a K-Line contactor with a low consumption coil.

The N.C. (95-96) relay can control 2 contactors of the specified size in parallel.

6.2 Wiring of the Modbus® Communication Network

Modbus® Communication Network

Introduction

This section describes how to connect a controller to an RS-485 Modbus network with an RJ45 or an open-style connector.

It presents 2 possible network topologies.

What's in this Section?

This section contains the following topics:

Topic	Page
Modbus® Communication Port Wiring Terminal Characteristics	305
Modbus® Network Connection	307

Modbus® Communication Port Wiring Terminal Characteristics

General

The main physical characteristics of a Modbus port are:

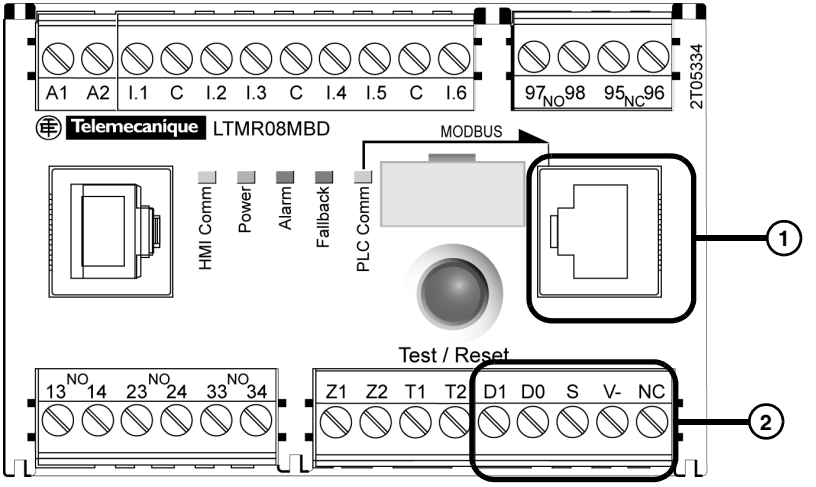
Physical interface	Multipoint 2-wire RS 485 - electrical networking
Connector	Terminal block and RJ45
Polarization	At master level

Physical Interface and Connectors

The LTM R controller is equipped with 2 connector types, on the front face:

1. a female shielded RJ45 connector,
2. an open-style, pull-apart, terminal block.

The figure shows the LTM R front face with the Modbus connectors:

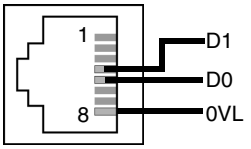


Both connectors are electrically identical. They follow the Schneider Electric interoperability standards. The product must be connected only through 1 port.

RJ45 Connector Pinout

The LTM R controller is connected to the Modbus network with an RJ45 connector in compliance with the following wiring:

Front view



The RJ45 wiring layout is:

Pin no.	Signal	Description
1	Do not connect	
2	Do not connect	
3	PMC	Port mode control (optional)
4	D1 or D(B)	Transceiver terminal 1
5	D0 or D(A)	Transceiver terminal 0
6	Do not connect	
7	VP	Positive 5...24 Vdc power supply (recommended)
8	0VL	Signal and power supply common

Open-Style Terminal Block

The LTM R controller front face shows a 5-position terminal block, with 5.08 mm spaced terminal positions.

The markings for the terminal positions, from left to right, are as listed below:

Terminal position	Signal
1	D1
2	D0
3	Shield
4	V- = 0VL
5	NC

Connection Characteristics

Modbus cables and connectors are described in *Terminal Wiring Characteristics, p. 288*.

Modbus® Network Connection

Connection to the RS 485 Bus

There are several ways in which you can connect an LTM R controller to the RS 485 bus:

- Connection to the bus via a splitter box (RJ45 wiring system)
- Connection to the bus via SCA type junction boxes.

The RS 485 standard allows variants of some characteristics:

- Polarization
- Line terminator
- Number of slaves
- Length of the bus

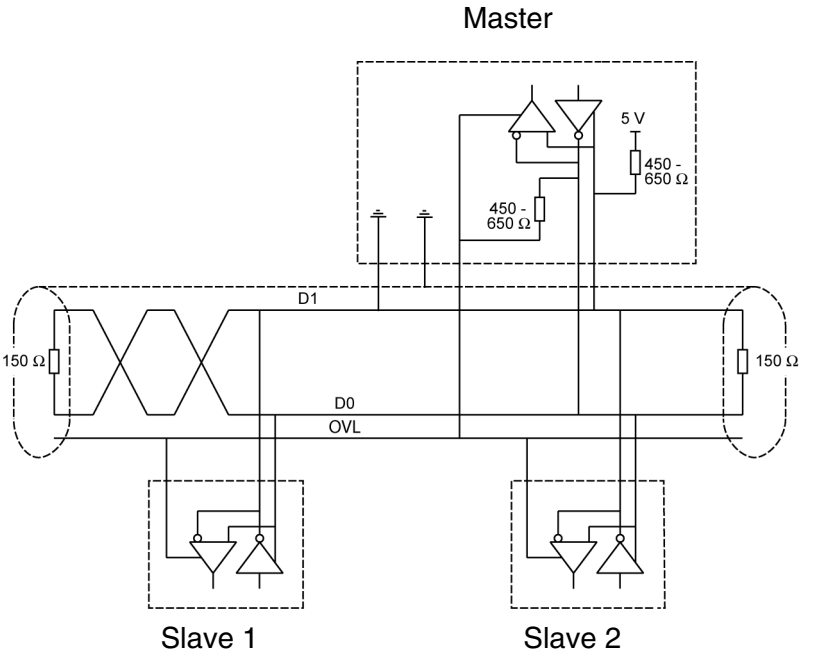
The Modbus specification published in 2002 on the Modbus.org site defines all these characteristics precisely. All new Telemecanique devices conform to this specification.

Standard Diagram

The standard diagram corresponds to the Modbus specification published in 2002 on the Modbus.org site (Modbus_over_serial_line_V1.pdf, Nov. 2002) and in particular to the 2-wire multidrop serial bus diagram.

The LTM R Controller conforms to this specification.

The simplified diagram is as follows:

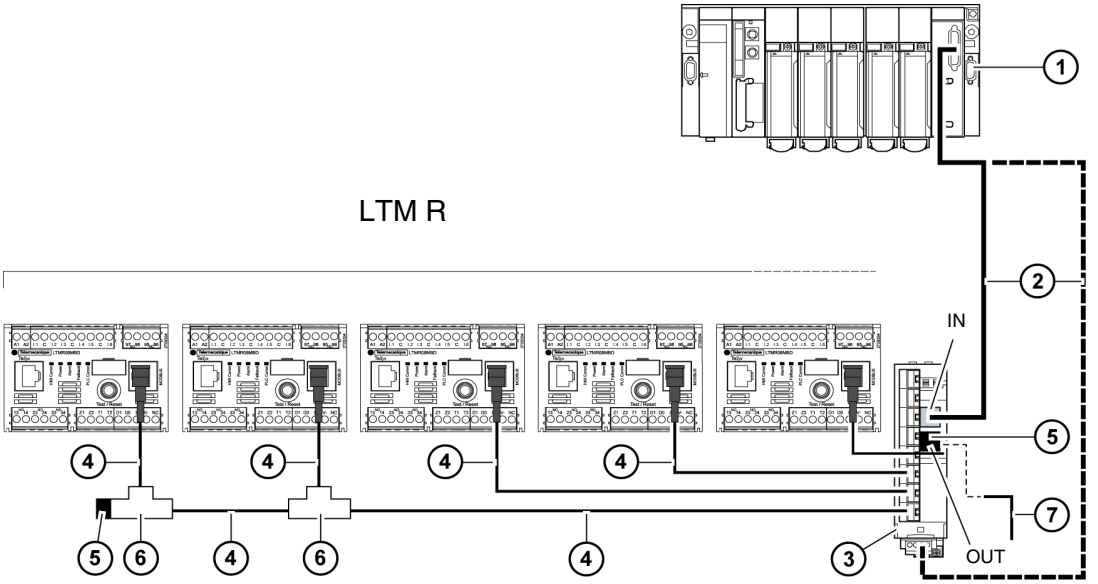


The characteristics for direct connection to the bus are as follows:

Designation	Description
Type of trunk cable	Single, shielded, twisted pair cable and at least a 3rd conductor
Maximum length of bus	1000 m (3,281 ft) at 19,200 bps
Maximum number of stations (without repeater)	32 stations, i.e., 31 slaves
Maximum length of tap-offs	• 20 m (66 ft) for one tap-off • 40 m (131 ft) divided by the number of tap-offs on the multiple junction box
Bus polarization	• A 450 to 650 Ω pulldown resistor at the 5 V • A 450 to 650 Ω pulldown resistor at the Common This polarization is recommended for the master. There is no polarization at the RS-485 terminal on the LTM R controller.
Line terminator	A 150 Ω resistor +/- 5%
Common polarity	Yes (Common), connected to the protective ground in at least one point on the bus

Connection to the Bus via a Splitter Box (RJ45 Wiring System)

The connection diagram for connection to the bus via a splitter box is as follows:



1 Master (PLC, PC, or communication module)
2 Modbus cable, depending on the type of master with polarization integrated on the master side or on another part of the bus. (See the List of connection accessories)
3 Modbus splitter box LU9 GC3
4 Modbus drop cables VW3 A8 306 R••
5 Line terminators VW3 A8 306 R
6 Modbus T-junction boxes VW3 A8 306 TF•• (with cable)
7 Modbus cable (to another splitter box) VW3 A8 306 R•• (replaces [5])

Note: Place a line terminator at each end of the bus to avoid malfunctions on the communication bus. A T-junction box should not have a free connector; if it is not connected to a slave or to the master, attach a line terminator.

Note: It is important to connect the bus to the "IN" input (or the screw terminals on the bottom) of the splitter box. Connection to another splitter box is made via the "OUT" output.

List of connection accessories:

Designation	Description	Reference
Modbus splitter box	10 RJ45 connectors and 1 screw terminal	LU9 GC3
Modbus T-junction boxes	With 0.3 m (1 ft) integrated cable	VW3 A8 306 TF03
	With 1 m (3.2 ft) integrated cable	VW3 A8 306 TF10
Line terminators for RJ45 connector	R = 150 Ω	VW3 A8 306 R

List of connection cables:

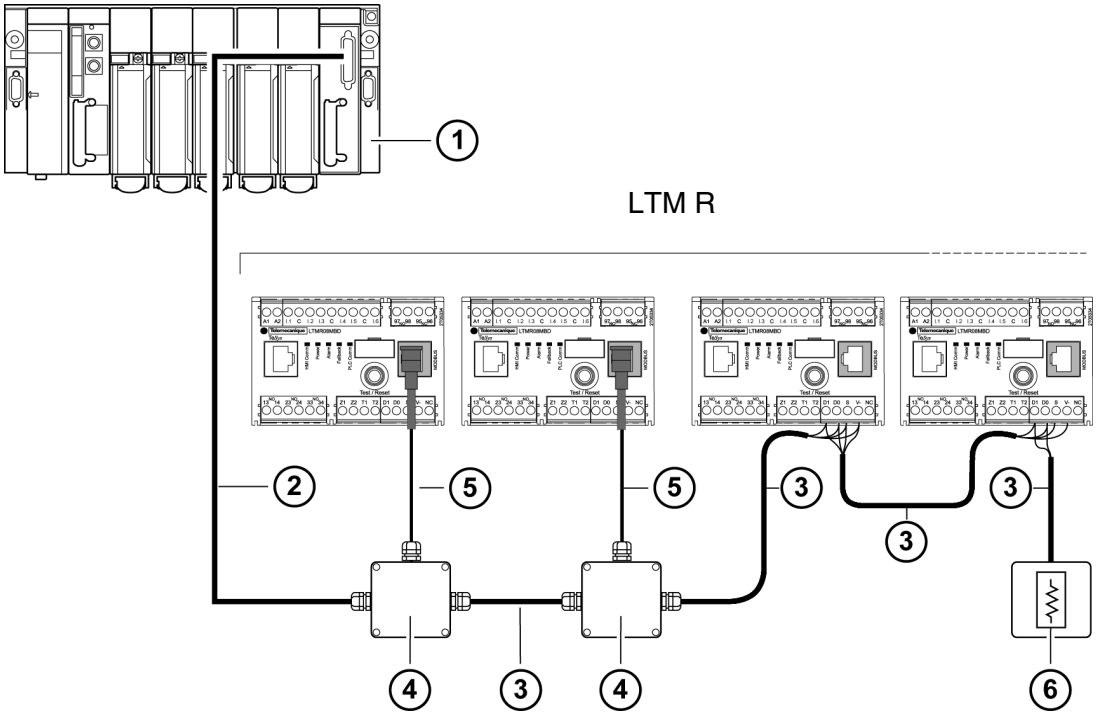
Designation	Connectors	Length	Reference
Cables for Modbus bus	1 RJ45 connector and 1 stripped end	3 m (9.8 ft)	VW3 A8 306 D30
	2 RJ45 connectors	0.3 m (1 ft)	VW3 A8 306 R03
		1 m (3.2 ft)	VW3 A8 306 R10
		3 m (9.8 ft)	VW3 A8 306 R30

List of Modbus connection accessories for RJ45 wiring system:

Type of master	Interface with the master	Description	Reference
Twido PLC	Mini-DIN RS-485 adapter or interface module	3 m (9.8 ft) cable equipped with a mini-DIN connector and an RJ45 connector	TWD XCA RJ030
	Screw terminal RS 485 adaptor or interface module	3 m (9.8 ft) cable equipped with an RJ45 connector and stripped at the other end	VW3 A8 306 D30
TSX Micro PLC	Mini-DIN RS-485 terminal port	3 m (9.8 ft) cable equipped with a mini-DIN connector and an RJ45 connector	TWD XCA RJ030
	PCMCIA card (TSX SCP114)	Stripped cable	TSX SCP CX4030
TSX Premium PLC	TSX SCY 11601 or TSX SCY 21601 module (25-pin SUB-D port)	Cable equipped with a 25-pin SUB-D connector and stripped at the other end (for connection to the screw terminals on the LU9GC3 splitter box)	TSX SCY CM6030
	PCMCIA card (TSX SCP114)	Stripped cable	TSX SCP CX4030
Serial port PC	PC with 9-pin male SUB-D RS-232 serial port	- RS-232/RS-485 converter	TSX SCA 72
		- 3 m (9.8 ft) cable equipped with an RJ45 connector and stripped at the other end (for connection to the screw terminals on the LU9GC3 splitter box)	VW3 A8 306 D30

Connection to the Bus via SCA Junction Boxes

The connection diagram for connection to the bus via SCA junction boxes is as follows:



1 Master (PLC, PC or communication module)
2 Modbus cable depending on the type of master with polarization integrated on the master side or on another part of the bus. (See the List of connection accessories)
3 Modbus cable TSX CSA•00
4 TSX SCA 50 junction box (without line polarization)
5 Modbus drop cable VW3 A8 306 D30
6 Line terminator: 150 Ω - 0.5 W

For Interference Protection:

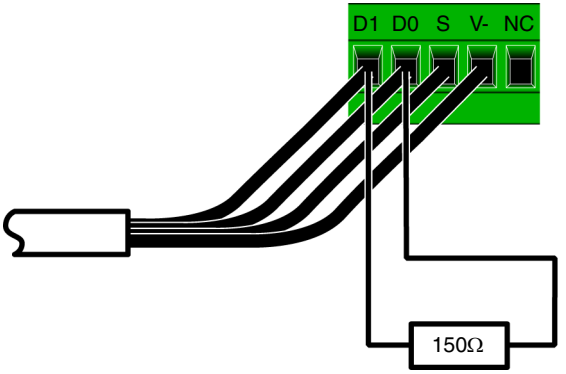
Use the Telemecanique cable with 2 pairs of shielded twisted conductors (references: TSX CSA100, TSX CSA200, TSX CSA500, VW3A8306TF••).

Keep the Modbus cable away from the power cables (at least 30 cm - 11.8 in.).

Create crossovers of the Modbus cable and the power cables at right angles, if necessary.

Note: For more information, consult guide TSX DG KBL F: "Electromagnetic Compatibility of Industrial Networks and Fieldbuses".

Line terminator cabling is as follows:



List of connection accessories:

Designation	Reference
Junction box 3 screw terminals and RC line terminator, connected with cable VW3 A8 306 D30	TSX SCA 50

List of connection cables:

Designation	Connectors	Length	Reference
Cable for Modbus bus	1 RJ45 connector and 1 stripped end	3 m (9.8 ft)	VW3 A8 306 D30
RS-485 double, shielded, twisted pair cables	Supplied without connector	100 m (328 ft)	TSX CSA 100
		200 m (656 ft)	TSX CSA 200
		300 m (984 ft)	TSX CSA 300

List of Modbus connection accessories for junction box on screw terminals:

Type of master	Interface with the master	Description	Reference
Twido PLC	Screw terminal RS 485 adaptor or interface module	Modbus cable	TSX CSA100 or TSX CSA200 or TSX CSA500
TSX Micro PLC	Mini-DIN RS-485 terminal port	Junction box	TSX P ACC 01
	PCMCIA card (TSX SCP114)	Cable equipped with a special connector and stripped at the other end	TSX SCP CX4030
TSX Premium PLC	TSX SCY 11601 or TSX SCY 21601 module (25-pin SUB-D port)	Cable equipped with a 25-pin SUB-D connector and stripped at the other end	TSX SCY CM6030
	PCMCIA card (TSX SCP114)	Cable equipped with a special connector and stripped at the other end	TSX SCP CX4030
Serial port PC	PC with 9-pin male SUB-D RS-232 serial port	RS 232/RS-485 converter and Modbus cable	TSX SCA 72 and TSX CSA100 or TSX CSA200 or TSX CSA500

Commissioning

7

At a Glance

Overview

This chapter provides an overview for commissioning the LTM R controller and the expansion module.

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Introduction	316
Required Information	318
First Power-up	320
Required Parameters	322
Commissioning Using Magelis® XBTN410 (1-to-1)	327
Commissioning Using PowerSuite™ Software	329
Modbus® Communication Checking	330
Verifying System Wiring	332
Verify Configuration	336

Introduction

Introduction

Commissioning must be performed after the physical installation of the LTM R controller, expansion module and other hardware devices.

The commissioning process includes:

- initialization of the installed devices, and
- configuration of the LTM R controller parameters that are required for operation of the LTM R controller, expansion module, and other system hardware

The person performing commissioning must be familiar with the system hardware, and how it will be installed and used in the application.

Hardware devices can include:

- motor
- voltage transformers
- external load current transformers
- ground current transformers
- communication network

The product specifications for these devices provide the required parameter information. You need to understand how the LTM R controller will be used to be able to configure the protection, monitoring, and control functions for the application.

For information about configuring control parameters, see *p. 207*.

For information about configuring protection parameters, see *p. 115*.

Initialization

The LTM R controller is ready to be initialized after the hardware installation is complete. To initialize the LTM R controller:

- be sure the motor is off, then
- turn on the LTM R controller

⚠ CAUTION

IMPROPER INITIALIZATION

Disconnect power to the motor before initializing the LTM R controller.

Failure to follow this instruction can result in injury or equipment damage.

Neither the LTM R controller nor the expansion module require additional hardware configuration (for example, turning dials, or setting dip-switches) to be initialized. When powered up for the first time, the LTM R controller enters an initial state and is ready for commissioning.

Configuration Tools

Identify the configuration control source–and the configuration tool–before configuring parameters. The LTM R controller and expansion module can be configured locally using an HMI device or remotely via the network connection.

The LTM R controller can be commissioned using:

- a Magelis® XBTN410 HMI on which a 1-to-1 software application has been installed
- a PC running PowerSuite™ software
- a PLC connected to the LTM R controller's network port.

The following parameters identify the configuration control source:

Parameter	Enables use of this tool	Factory setting
Config Via HMI Keypad Enable	Magelis XBTN410 device keypad	Enabled
Config Via HMI Engineering Tool Enable	PC running PowerSuite software	Enabled
Config Via Network Port Enable	the network port (PLC)	Enabled

Note: The Magelis XBTN410 HMI can commission the LTM R controller only if a 1-to-1 software application is installed. If a 1-to-many software application is installed, the Magelis XBTN410 HMI can operate up to 8 LTM R controllers after commissioning, but cannot perform commissioning for any LTM R controller. For information on the use of software application files, see *p. 343*.

This chapter describes commissioning performed using either the Magelis XBTN410 HMI in a 1-to-1 configuration, or PowerSuite software.

Commissioning Process

The commissioning process remains the same, regardless which configuration tool you select. This process includes the following stages:

Stage	Description
First power-up	The LTM R controller initializes, and is ready for parameter configuration.
Configuring required settings	Configure these parameters to move the LTM R controller out of its initialization state. The LTM R controller is ready for operations.
Configuring optional settings	Configure these parameters to support the LTM R controller functions required by the application.
Verifying hardware	Check hardware wiring.
Verifying the configuration	Confirm accurate parameter settings.

Required Information

Required Information

The following information is required to commission the LTM R controller and expansion module. The selection column shows the specific values or the range supported by the LTM R controller and expansion module.

Commissioning information	Specific information or parameter	Selections
LTM R controller type used in application	Control Voltage	• 100-240 Vac • 24 Vdc
	Current Range	• 8 A • 27 A • 100 A
	Network Protocol	• Modbus® • DeviceNet™ • CANopen • Profibus
Expansion module type used in application	Control Voltage	• None • 100-240 Vac • 24 Vdc
HMI	Type used in application	• Magelis® 1-to-1 • PowerSuite™ software
Network	Is a network used in application?	• No • Yes
Motor settings	Full Load Current Max (FLCmax)	• 0.4…100 A (without external CTs), or • 0.4...810 A (with external CTs)
	Motor Trip Class	• 5…30 in increments of 5
	Motor Phases	• Single-phase motor • 3-phase motor
	Motor Nominal Voltage	• 110…690 V
Controller operating mode	Motor Operating Mode	• Overload • Independent • Reverser • Two-Step • Two-Speed
Control wiring type	Motor Operating Mode	• 2-wire (maintained) • 3-wire (impulse)

Commissioning information	Specific information or parameter	Selections
Control source	Control Local Channel Setting	• Local terminal only • Local HMI only • Remote only • Selectable Remote-HMI • Selectable Remote-terminal
Control transition type	If Selectable, Bumpless Transition Mode	• Bump • Bumpless
External Load CTs	Used in application?	• No • Yes
	If yes, Load CT Primary	• 1…65535
	If yes, Load CT Secondary	• 1…500
Load CT Multiple Passes		• 1…100
Ground fault CT settings (optional)	Used in application?	• No • Yes
	If Yes: Ground CT Primary	• 1…65535
	If Yes: Ground CT Secondary	• 1…65535
Motor temperature sensor	Type used in application	• None • Binary • PTC analog • NTC analog
	If PTC analog or NTC analog: Wiring resistance	• Known • Not known
	If PTC analog or NTC analog: Fault Threshold and Warning Threshold (Trip resistance)	• 100…5100 Ω (in 0.1 Ω increments)

Required Documents

The source of much of the required information, described above, will be documents that describe your application. These documents can include:

- wiring diagrams for the LTM R controller and expansion module
- a list of all general parameters and protection parameters that must be configured, and the setting value for each parameter
- design documents for the motor application
- motor specifications and characteristic
- specifications describing each hardware device to be added to the system

First Power-up

Overview

First power-up describes the first time power is cycled to:

- a new LTM R controller, or
- an LTM R controller that has been previously commissioned, but whose parameter settings have been restored to the factory defaults, either as a result of:
  - execution of the Clear All Command, or
  - a firmware upgrade

On first power-up, the LTM R controller enters a locked, non-configured state–called the initialized state–and the Controller System Config Required parameter is turned On. The LTM R controller exits this state only after certain parameters–called required parameters–have been configured.

Using the Magelis® XBTN410 HMI, configuring the SysConfig menu parameters clears the Controller System Config Required parameter and brings the LTM R controller out of initialization.

Using PowerSuite™ software, all parameters–both required and optional–are configured offline, then downloaded to the LTM R controller in a configuration file. A successful download clears the Controller System Config Required parameter, and brings the LTM R controller out of initialization.

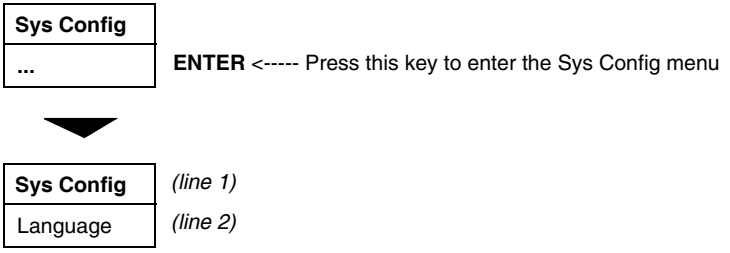
In either case, the LTM R controller is no longer locked, and is ready for operations. For information on operating states, see *p. 214*.

In a 1-to-1 configuration, the Magelis XBTN410 HMI displays the SysConfig menu the very first time the LTM R controller powers up. The SysConfig menu contains parameters that are essential to the operation of the LTM R controller and must be configured during commissioning.

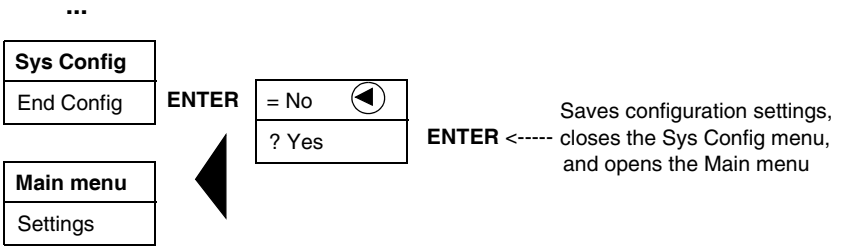
After the SysConfig menu parameters are configured and saved, the HMI closes the SysConfig menu and displays the Main menu. The Main menu contains additional parameters with factory default settings that also must be configured as part of the commissioning process.

First Power-up in the Magelis XBTN410

The first time the LTM R controller powers up after leaving the factory, the Magelis XBTN410 LCD automatically displays the Sys Config menu:



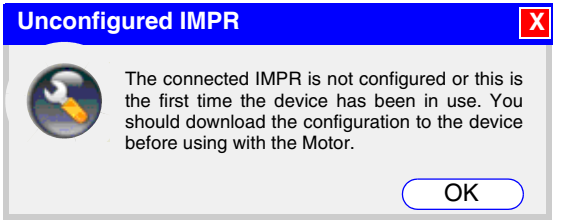
When the settings of the Sys Config menu are saved, the Sys Config menu closes and the LCD displays the Main menu:



The Sys Config menu parameters are configured as part of the commissioning process. For more information on the Sys Config menu, see *p. 327*.

First Power-up in PowerSuite™ Software

The first time the LTM R controller power up after leaving the factory, PowerSuite software displays the following message:


Unconfigured IMPR
X
The connected IMPR is not configured or this is the first time the device has been in use. You should download the configuration to the device before using with the Motor.
OK

This message indicates that the LTM R controller is in its initialized state. You must download a configuration file–containing all the settings–before the LTM R controller can be used in operations.

For information on how to transfer a configuration file from your PC to the LTM R controller, see *p. 432*.

Required Parameters

Introduction

The parameters listed below must be configured before the LTM R controller can be commissioned into service. The LTM R controller remains locked in its initialized state until all of these required parameters are configured.

In the Magelis® XBTN410 HMI, the required parameters are located in either or both the:

- Sys Config menu, or
- Main menu

For more information about the Sys Config menu, see *p. 327*. For information on the Main menu, see *p. 363*. For information on navigating the Magelis XBTN410 HMI menu structure, see *p. 357*.

In PowerSuite™ software, all required parameters are located in the Settings branch of the tree control. For information about the PowerSuite software interface, see *p. 434*. For information about editing parameters using PowerSuite software see *p. 436*.

In addition to the required parameters, you may also need to configure additional optional parameters. In the Magelis XBTN410 HMI, optional parameters are found in the Main menu. In PowerSuite software, they are found in the Settings branch of the tree control, along will the required parameters.

General Parameters

Required parameters include the following general settings:

Parameter name	Setting range	Factory default	Sys Confg	Main
Language	• English • Français • Español • Deutsch • Italiano	English	X	X
Date And Time Setting	Year • 2006…2099	2006	X	X
	Month • January • February • March • April • May • June • July • August • September • October • November • December	January	X	X
	Day • 1…31	1	X	X
	Hour • 00…23	00	X	X
	Minute • 00…59	00	X	X
	Second • 00…59	00	X	X
X = The parameter is located in the indicated menu in the Magelis XBTN410 HMI (1-to-1). **– = The parameter is not located in the indicated menu in the Magelis XBTN410 HMI (1-to-1).**				

Motor Parameters

Required parameters include the following motor settings:

Parameter name	Setting range	Factory default	Sys Config	Main
Motor Nominal Voltage	110…690 V	400 V	X	X
Motor Phases	• 3-phase motor • 1-phase motor	3-phase motor	X	–
Motor Phases Sequence	• A-B-C • A-C-B	A-B-C	X	X
Motor Operating Mode	• Overload - 2-wire • Overload - 3-wire • Independent - 2-wire • Independent - 3-wire • Reverser - 2-wire • Reverser - 3-wire • Two-Step - 2-wire • Two-Step - 3-wire • Two-Speed - 2-wire • Two-Speed - 3-wire • Custom	Independent 0 3-wire	X	–
Control Direct Transition	• Yes • No	No	X	–
Motor Transition Timeout	000...999 s	10 s	X	–
Motor Step 1 To 2 Threshold[1]	20…800% FLC, in increments of 1%	50%	X	–
Motor Step 1 To 2 Timeout[1]	000...999 s	50 s	X	–
Motor Nominal Power	0.1…999.9 kW in increments of 0.1 kW	7.5 kW	X	X
Motor Aux Fan Cooled	• Yes • No	No	X	X
Motor Temp Sensor Type	• None • PTC binary • PTC analog • NTC analog	None	X	–
[1] Only for 2 Step Operating Mode				
X = The parameter is located in the indicated menu in the Magelis XBTN410 HMI (1-to-1). **– = The parameter is not located in the indicated menu in the Magelis XBTN410 HMI (1-to-1).**				

Load CT Parameters

Required parameters include the following load current transformer settings:

Parameter	Setting Range	Factory Default	Sys Config	Main
Load CT Ratio	• None • 10:1 • 15:1 • 30:1 • 50:1 • 100:1 • 200:1 • 400:1 • 800:1 • Other Ratio	No Default	X	–
Load CT Multiple Passes	1…100	1	X	–
Load CT Primary	1…65535	1	X	–
Load CT Secondary	1…500	1	X	–
X = The parameter is located in the indicated menu in the Magelis XBTN410 HMI (1-to-1). **– = The parameter is not located in the indicated menu in the Magelis XBTN410 HMI (1-to-1).**				

Ground CT Parameters

Required parameters include the following ground current settings:

Parameter	Setting Range	Factory Default	Sys Config	Main
Ground CT Ratio	• None • 100:1 • 200:1.5 • 1000:1 • 2000:1 • Other Ratio	No Default	X	–
Ground CT Primary	1…65535	1	X	–
Ground CT Secondary	1…65535	1	X	–
X = The parameter is located in the indicated menu in the Magelis XBTN410 HMI (1-to-1). **– = The parameter is not located in the indicated menu in the Magelis XBTN410 HMI (1-to-1).**				

Contactor Parameters

Compulsory parameters that apply to the specific contactor used in the application have the following configurable settings:

Parameter	Setting Range	Factory Default	Sys Config	Main
Contactor Rating	1…1000 A	810 A	X	–
X = The parameter is located in the indicated menu in the Magelis XBTN410 HMI (1-to-1). **– = The parameter is not located in the indicated menu in the Magelis XBTN410 HMI (1-to-1).**				

Commissioning Using Magelis® XBTN410 (1-to-1)

Sys Config Menu

When the LTM R controller first powers up, the Magelis® XBTN410 HMI in 1-to-1 configuration displays its Sys Config menu. The Sys Config menu is displayed when the LTM R controller is in its initialized state, and must be configured before the it can be operated.

Configuration of the Sys Config menu parameters is complete when the End Config setting is set to **Yes**. This clears the Controller System Config Required parameter.

After the Sys Config menu has been configured, the Magelis XBTN410 HMI displays the Main menu on subsequent power-ups. The HMI will not again display the Sys Config menu unless:

- the Controller System Config Required parameter has been cleared by:
  - executing a Clear All Command, or
  - upgrading the LTM R controller's firmware
- Sys Config is selected in the Services menu (see *p. 382*)

Sys Config Menu Structure The SysConfig menu contains the following 4 levels of sub-menu items:

Level 2	Level 3	Level 4	Level 5	Parameter name
Language				HMI Language Setting
Date-Time	Year			Date And Time Setting
	Month			
	Day			
	Hour			
	Minutes			
	Seconds			
Motor	Nom Voltage			Motor Nominal Voltage
	Phases			Motor Phases
	Phase Seq.			Motor Phases Sequence
	Oper Mode			Motor Operating Mode
	Dir Transit			Control Direct Transition
	Transit Time			Motor Transition Timeout
	2 Step Level			Motor Step 1 To 2 Threshold
	2 Step Time			Motor Step 1 To 2 Timeout
	Aux Fan			Motor Aux Fan Cooled
	Temp Sensor			Motor Temp Sensor Type
	Gr CT Mode			Ground Current Mode
Load CT	Load CT Ratio			Load CT Ratio
			Primary	Load CT Primary
			Secondary	Load CT Secondary
Load CT Multiple Passes				Load CT Multiple Passes
GF CT Ratio		Primary		Ground CT Primary
		Secondary		Ground CT Secondary
Contactor Rtg				Contactor Rating
Th Overload				Thermal Overload Mode
Network Address				Network Port Address Setting
End Config				Controller System Config Required

Commissioning Using PowerSuite™ Software

Introduction

A PC running PowerSuite software can commission the LTM R controller by configuring required parameters at first power-up.

The procedure to configure parameters using PowerSuite software is the same, both at first power-up, or at any later time. In all cases, use PowerSuite software to:

1 configure parameters offline

2 save your settings to a configuration file

3 transfer the configuration from your PC to the LTM R controller

For information about configuring parameters using PowerSuite software, see *p. 436*.

For information about working with configuration files, including transferring configuration settings from your PC to the LTM R controller, see *p. 430*.

Power Supply and Connections

The PC requires its own power source and must be connected to the local HMI port with RJ45 connector on either the LTM R controller the expansion module.

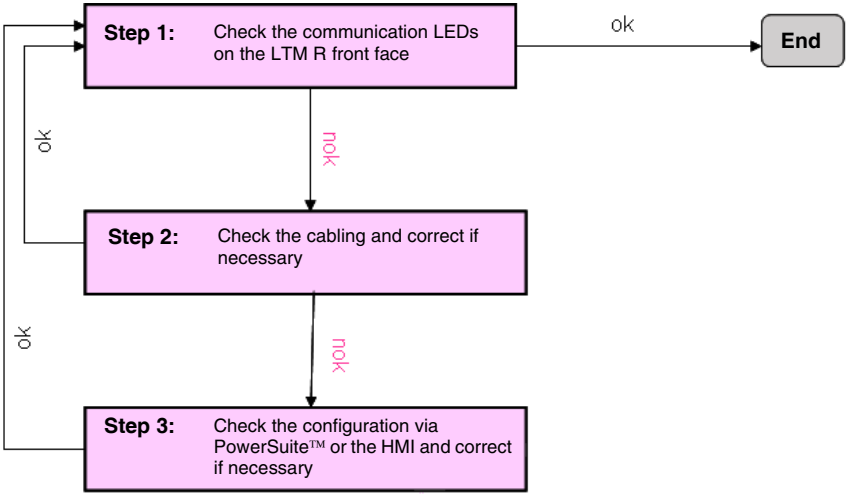
Modbus® Communication Checking

Introduction

Configure the networking function last. Even when the connectors are plugged in, communication between the controller(s) and the PLC cannot start until you enter the correct communication parameters via PowerSuite™ software or the HMI. To select the communication parameters, see *p. 447*.

You can then check whether your system can communicate properly.

The Modbus communication checking sequence is:



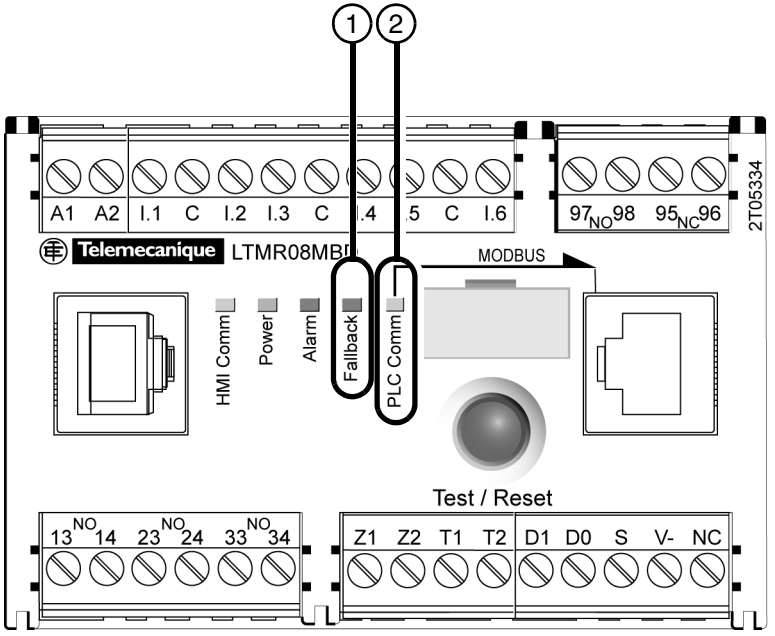
Step 1

On the LTM R front face, check the following 2 LEDs:

1. Fallback

2. PLC Comm

The figure shows the LTM R front face with both Modbus communication LEDs:



The communication **Fallback** is indicated by a **red LED** (1).

If the red Fallback LED is...	Then...
OFF	the LTM R is not in communication fallback mode
ON	the LTM R is in communication fallback mode

The Modbus communication status, marked as **PLC Comm**, is indicated by a **yellow LED** (2).

If the yellow PLC Comm LED is...	Then...
OFF	the LTM R is not communicating
Blinking	the LTM R is exchanging frames (receiving or sending)

Step 2

If the product should be communicating but the LEDs are not lit, check the cables and connectors and correct any connection problems.

Step 3

If the product is still not communicating, check the configuration via:
- PowerSuite™ software, or
- the HMI.

The communication failure can be the result of a wrong address, speed or parity; an incorrect PLC configuration; etc.

Verifying System Wiring

Overview

After all required and optional parameters have been configured, be sure to check your system's wiring, which can include:

- motor power wiring
- LTM R controller wiring
- external current transformer wiring
- diagnostic wiring
- I/O wiring

Motor Power Wiring

To verify the motor power wiring, check the following:

Look at	Action
The motor nameplate	Confirm that the motor generates current and voltage within the ranges of the LTM R controller.
The power wiring diagram	Visually confirm that the actual power wiring matches the intended power wiring, as described in the power wiring diagram.
The list of faults and warnings in PowerSuite™ software or the LCD display of the Magelis® XBTN410 HMI	Look for any of the following faults or warnings: • overpower • underpower • over power factor • under power factor
The list of all or read only parameters in PowerSuite software or the scrolling HMI display of the Magelis XBTN410 HMI	Look for unexpected values in the following parameters: • active power • reactive power • power factor

Control Circuit Wiring

To verify control circuit wiring, check the following:

Look at	Action
The control wiring diagram	Visually confirm that the actual control wiring matches the intended control wiring, as described in the control wiring diagram.
The LTM R controller Power LED	If the LED is off, the LTM R controller may not be receiving power.
The LTM R controller HMI LED	If the LED is off, the LTM R controller may not be communicating with the expansion module.
The expansion module Power LED	If the LED is off, the expansion module may not be receiving power.

Current Transformer Wiring

Verify the load current transformer wiring and, if the application includes external load current transformers, also verify that wiring by checking the following:

Look at	Action
The external CT wiring diagram	Visually confirm that the actual wiring matches the intended wiring, as described in the wiring diagram.
The following load CT parameter settings, using PowerSuite™ software: • Load CT Ratio • Load CT Primary • Load CT Secondary • Load CT Multiple Passes	Confirm that the Load CT Ratio parameter, or the combination of Load CT Primary and Load CT Secondary parameters accurately reflect the intended load CT ratio. Visually confirm that the Load CT Multiple Passes parameter accurately reflects the number of passes the wiring makes through the LTM R controller's embedded CT windows.
The following load motor parameter setting, using PowerSuite software: • Motor Phases	Visually confirm that the motor and LTM R controller are wired for the number of phases set in the Motor Phases parameter.
The following load motor parameter setting, using either PowerSuite software or the LCD display of the Magelis® XBTN410 HMI: • Motor Phases Sequence	If the motor is a 3-phase motor, visually check that the phase wiring sequence matches the Motor Phases Sequence parameter setting.

Diagnostic Wiring

Verify the wiring for any motor temperature sensing device or external ground current transformer, if the application includes these devices, by checking the following:

Look at	Action
The wiring diagram	Visually confirm that the actual wiring matches the intended wiring, as described in the wiring diagram.
The external ground CT specifications - and - The following ground CT parameter settings, using PowerSuite™ software: • Ground CT Primary • Ground CT Secondary	Confirm that the combination of Ground CT Primary and Ground CT Secondary parameters accurately reflect the intended ground CT ratio.
The motor temp sensor specifications -and - The following parameter setting, using either PowerSuite software or the LCD display of the Magelis® XBTN410 HMI: • Motor Temp Sensor	Confirm that the motor temp sensor actually employed is the same sensor type as set in the Motor Temp Sensor parameter.

I/O Wiring

Verify the wiring for any I/O connections by checking the following:

Look at	Action
The wiring diagram	Visually confirm that the actual wiring matches the intended wiring, as described in the wiring diagram.
The Aux1, Aux2, and Stop buttons on the Magelis® XBTN410 HMI - and - The following parameter setting, using either PowerSuite™ software or the LCD display of the Magelis XBTN410 HMI: ● Control Local Channel Setting	Confirm that each command performs the intended start or stop function, when control is via the local terminal strip or the local HMI port.
The Reset button on the Magelis XBTN410 HMI - and - The following parameter setting, using either PowerSuite software or the LCD display of the Magelis XBTN410 HMI: ● Thermal Overload Fault Reset	Confirm that the local HMI can command a manual fault reset, when control is set to manual.
The PLC, if the LTM R controller is connected to a network - and - The following parameter setting, using either PowerSuite software or the LCD display of the Magelis XBTN410 HMI: ● Thermal Overload Fault Reset	Confirm that the PLC can command the intended start, stop and remote reset functions.

Verify Configuration

Overview

The final step in the commissioning process is to verify that all configurable parameters used in your application are properly configured.

When performing this task, you will need a master list of all the parameters you intended to configure and their desired settings. You must compare the actual settings of configured parameters against this list.

Tools

Only PowerSuite™ software can display all configured parameters, including both required and optional parameters. These are found in the Settings branch of the tree control.

The Magelis® XBTN410 HMI can display all parameters in its Main menu, but cannot display all parameters located only in its Sys Config menu.

Process

Verifying parameter settings is a 3-part process:

1. Transfer the configuration file from the LTM R controller to the PowerSuite software running in your PC. This lets you view the LTM R controller's present parameter settings.
   For information on transferring files from the LTM R controller to your PC, see *p. 431*.
2. Compare the master list of intended parameters and settings against the same settings located in the Settings branch of PowerSuite software's tree control.
3. Change the configuration settings as desired. Do this using either:
   - PowerSuite software, then download the edited file from your PC to the LTM R controller
     For information on transferring files from your PC to the LTM R controller, see *p. 432*.
   - Magelis XBTN410 HMI. To edit parameters located in the:
     - Main menu, navigate to the s main menu settings and make the appropriate edits
     - Sys Config menu, navigate to the Services menu and use the Sys Config command to reopen the SysConfig menu, where you can again make and save edits
       For information about required settings, see *p. 322*.

Use

8

At a Glance

Overview

This chapter describes:

- the user interface devices and the hardware configurations you can use to operate the LTM R controller
- how to set parameters with each user interface
- how to perform monitoring, fault handling, and control functions with each user interface.

What's in this Chapter?

This chapter contains the following sections:

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8.2	Using the LTM R Controller Alone	339
8.3	Configuring the Magelis® XBTN410	343
8.4	Using the Magelis® XBTN410 HMI (1-to-1)	348
8.5	Using the Magelis® XBTN410 HMI (1-to-many)	391
8.6	Using PowerSuite™ Software	426
8.7	Using the Modbus® Communication Network	445

8.1 Introduction

Hardware Configurations

Overview

The LTM R controller—either alone or connected to an expansion module—can be operated with or without a user interface device.

In any configuration, the LTM R controller can be configured to perform monitoring, fault management, motor protection and control functions.

All user interface devices require an independent power source.

Communications

User interface devices and their communications interfaces include:

User interface device	Communicates via the
Magelis® XBTN410 HMI	HMI port via the local RJ45 connector on the LTM R controller or expansion module
PC running PowerSuite™ software	HMI port via the local RJ45 connector on the LTM R controller or expansion module
Network PLC	Network port on the LTM R controller via the network RJ46 connector or terminal wiring

8.2 Using the LTM R Controller Alone

Stand Alone Configuration

Overview

When operated without a user interface, the LTM R controller—either alone or connected to an expansion module—provides monitoring, protection, fault management and control functionality.

Note: Although the LTM R controller can be operated without a user interface, you must to use one of the following devices for the purpose of configuring parameters. After parameters are configured, the device can be detached and the LTM R controller can operate in stand-alone configuration. Parameters can be configured using either:

- a Magelis® XBTN410 HMI
- PowerSuite™ software.

After parameters are configured, use the following controls to operate the LTM R controller:

Use this control	To

• LEDs:
  • 5 LTM R controller LEDs
  • 5 expansion module LEDs
	Monitor the state of the LTM R controller and expansion module

• LTM R controller Test/Reset button	Manage faults

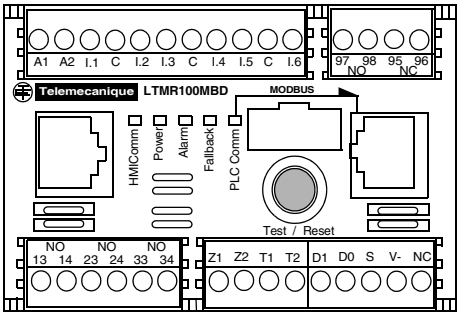
• Programmed operating parameters
• Digital inputs:
  • 6 LTM R controller inputs
  • 4 expansion module inputs
	Control the:
	• LTM controller
	• expansion module
	• motor
	• power and control wiring
	• any connected sensors, including
	  • motor temp sensors
	  • external ground fault CTs

• Programmed protection parameters	Protect the: • LTM R controller • expansion module • motor • equipment

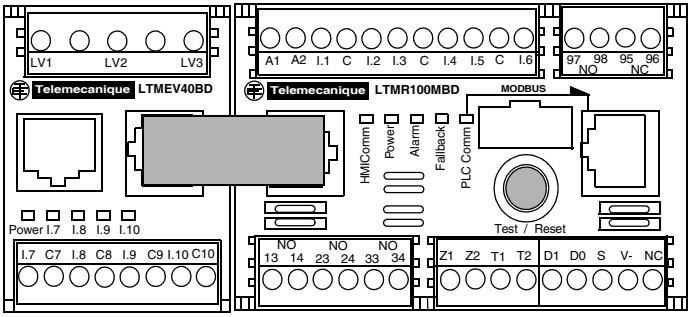
Configurations

The stand-alone physical configurations of the LTM R controller—with and without a connected expansion module—are depicted below:

The LTM R controller alone



The LTM R controller and LTM E expansion module



LTM R Controller LEDs

Use the 5 LEDs on the face of the LTM R controller to monitor its state, as follows:

LED	Color	Describes	Indicates
HMI Comm	yellow	Communication activity between LTM R controller and expansion module	• On = communication • Off = no communication
Power	green	LTM R controller power or internal fault condition	• Solid green = power on, no internal faults, and motor off • Flashing green = power on, no internal faults, and motor on • Off = power off, or internal faults exist.
Alarm	red	Protection fault or warning, or internal fault condition	• Solid red = internal or protection fault • Flashing red (2 x per s) = warning • Flashing red (5 x per s) = load shed or rapid cycle condition • Off = no faults, warnings, load shed or rapid cycle (when power is On)
Fallback	red	Communication connection between LTM R controller and network module	• Solid red = in fallback • Off = not in fallback (no power)
PLC Comm	yellow	Communication activity on the network bus	• flashing yellow (0.2 s on,1.0 s off) = network bus communication • Off = no network bus communication

Expansion Module LEDs

Use the 5 LEDs on the face of the expansion module to monitor its operating and communications state, as follows:

LED	Color	Describes	Indicates
Power	green or red	Module power or internal fault condition	• Solid green = power on with no internal faults • Solid red = power on with internal faults • Off = power off
Digital Inputs I.7, I.8, I.9 and I.10	yellow	State of input	• On = input activated • Off = input not activated

Test / Reset

Use the Test / Reset button to perform the following functions:

Function	Description	Procedure
Fault reset	Resets all faults that can be reset. See *p. 254* for more information about resetting faults.	Press the button and release within 3 s.
Self-test (See *p. 503*)	Performs a self-test if: ● motor is stopped ● no faults exist ● self-test function is enabled.	Press and hold the button for more than 3 s up to and including 15 s.
Induce a fault	Puts the LTM R controller into internal fault condition.	Press and hold the button down for more than 15 s.

8.3 Configuring the Magelis® XBTN410

At a Glance

Summary

The Magelis XBTN410 HMI can be used in a:

- 1 HMI to 1 LTM R controller (1-to-1) physical configuration, or
- 1 HMI to up to 8 LTM R controllers (1-to-many) physical configuration.

In each configuration, the HMI presents a unique user interface, including both LCD display and keypad. Each configuration requires the use of a distinct:

- software application file, and
- keypad label

This section shows you how to obtain and install a software application in the Magelis XBTN410 for a 1-to-1 or 1-to-many configuration.

Refer to the Telemecanique Magelis Instruction Sheet that ships with the Magelis XBTN410 HMI for instructions on selecting and installing the keypad label that is appropriate for your configuration.

What's in this Section?

This section contains the following topics:

Topic	Page
Installing Magelis® XBT L1000 Programming Software	344
Download 1-to-1 and 1-to-many Software Application Files	346
Transferring Application Software Files to Magelis® XBTN410 HMI	347

Installing Magelis® XBT L1000 Programming Software

Overview

The LTM R controller comes with a copy of Magelis® XBT L1000 programming software. You need to:

- install the Magelis XBT L1000 programming software on your PC, and
- use it to transfer either a 1-to-1 or 1-to-many software application to the Magelis XBTN410 HMI.

Note: Magelis XBT L1000 programming software is a powerful programming tool. This document describes only its utility in opening and transferring pre-programmed software applications to the Magelis XBTN410 HMI. For more information about the Magelis XBT L1000 programming software, consult its help file and printed documentation.

For instructions on how to download 1-to-1 and 1-to-many software applications, see *p. 346*.

For instructions on how to transfer 1-to-1 and 1-to-many software applications from your PC to the Magelis XBTN410 HM, see *p. 347*.

Installation Steps

To install the Magelis XBT L1000 programming software on your PC:

Step	Action
1	Place the installation disk into your PC's disk drive. The installation program should begin.
2	If the installation program does not begin, use Microsoft® Windows® Explorer to navigate to and click on the file **Setup.exe**.
3	If any screens appear that do not require action, click **Next**.
4	In the language screen, select a language and click **OK**.
5	In the name and company screen, type in your name and your company name (or accept the defaults) and click **Next**.
6	If a screen appears warning you that protocols will be uninstalled, click **Yes** to continue.
7	In the Protocols Choices screen, be sure that **Modbus** is selected, then click **Next**.
8	In the Select Components screen, make no selections then click **Next**.
9	In the Choose Destination Location screen, either accept the default path or use the Browse button to navigate to a new one, then click **Next**.
10	In the Start Copying Files screen, review your selections then click: • **Back** to return to earlier screens and make changes • **Next** to proceed to the final screen.
11	In the Finish screen, click **Finish**. The Magelis XBT L1000 programming software is installed.

Download 1-to-1 and 1-to-many Software Application Files

Overview

You must download the software application file required by your installation of the Magelis® XBTN410 HMI from the www.telemecanique.com website.

From the Telemecanique website, you can freely obtain the following software application files:

File name	Description
LTM_1T1_(language)_(version).dop	1-to-1 application file
LTM_1T8_(language)_(version).dop	1-to-many application file

The HMI can save and use only one software application file at a time. If you change your design from 1-to-1 to 1-to many, or vice-versa, you will need to transfer the appropriate software application file to the HMI to support the new configuration.

For instructions on installing the Magelis XBT L1000 programming software, see *p. 344*.

For instructions on transferring application files from the Magelis XBT L1000 programming software in your PC to the Magelis XBTN410 HMI, see *p. 347*.

Transferring Application Software Files to Magelis® XBTN410 HMI

Overview

After you have installed the Magelis® XBT L1000 programming software on your PC and downloaded the required 1-to-1 or 1-to-many application software file, you are ready to transfer the application software file to the Magelis XBTN410 HMI.

The Magelis XBTN410 HMI can save and use only 1 software application at a time. If you change your physical configuration from 1-to-1 to 1-to-many, or vice-versa, you will need to transfer to the HMI the appropriate software application file to support the new configuration.

For instructions on installing the Magelis XBT L1000 programming software, see *p. 344*.

For instructions on downloading software application files, see *p. 346*.

Transfer Steps

To transfer a software application file from Magelis XBT L1000 programming software on your PC to the Magelis XBTN410 HMI:

Step	Action
1	Supply power to the Magelis XBTN410 HMI.
2	Connect the PC 9-PIN Com1 port to the 25-pin data port on the HMI using an XBT Z915 programming cable. The HMI LCD reads: "FIRMWARE VX.X WAITING FOR TRANSFER"
3	Start up the Magelis XBT_L1000 programming software.
4	Close all child windows in the programming software.
5	In the File menu, select **Open**. The Open dialog is displayed.
6	In the Open dialog, navigate to the 1-to-1 or 1-to-many software application file (with a .dop extension) and click **Open**. The programming software displays the selected file.
7	In the Transfers menu, select **Export**.
8	When notified that the Export command will destroy the existing application, click **OK** to continue the export. The HMI LCD indicates: "DOWNLOAD IN PROGRESS" and then "DOWNLOAD COMPLETED"
9	Click **OK** when the programming software reports "Transfer accomplished successfully".

8.4 Using the Magelis® XBTN410 HMI (1-to-1)

At a Glance

Summary

This section shows you how to use the Magelis® XBTN410 HMI to operate a single LTM R controller in a 1 HMI to 1 LTM R controller (1-to-1) configuration.

See *p. 391* for instructions on how to use a single Magelis XBTN410 HMI to operate up to 8 LTM R controllers in a 1-to-many configuration.

The 1-to-1 and the 1-to-many configurations each present a unique:

- user interface (LCD display and keypad)
- menu structure

What's in this Section?

This section contains the following topics:

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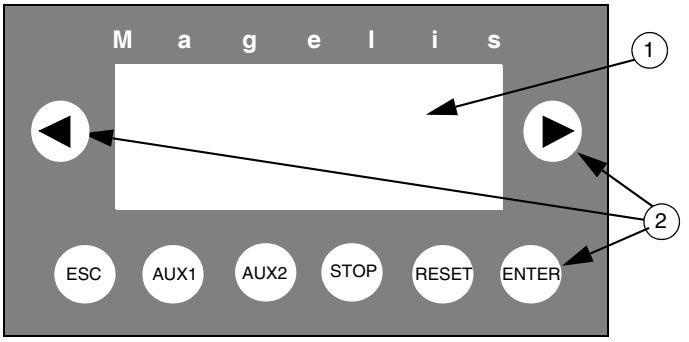
Physical Description (1-to-1)	349
LCD Display (1-to-1)	351
Navigating the Menu Structure (1-to-1)	357
Editing Values (1-to-1)	358
Menu Structure (1-to-1)	362
Main Menu (1-to-1)	363
Main Menu - Settings (1-to-1)	364
Main Menu - Statistics (1-to-1)	371
Main Menu - Product ID (1-to-1)	378
Monitoring Using the Scrolling HMI Display (1-to-1)	379
Main Menu - Services (1-to-1)	382
Fault Management (1-to-1)	386
HMI Keypad Control (1-to-1)	389

Physical Description (1-to-1)

1-to-1 Interface

In a 1-to-1 physical configuration, the Magelis® XBTN410 HMI looks like this:



1 LCD display
2 8 button keypad

1-to-1 Keypad

The 1-to-1 configuration requires a customized keypad label for the 4 buttons–AUX1, AUX2, STOP, and RESET–located at the bottom of the HMI. You will need to type or print the button names on a blank keypad label, then insert the label into the HMI.

For instructions on selecting, customizing, and installing a customized keypad label, refer to the Telemecanique Magelis Instruction Sheet that ships with the HMI.

In a 1-to-1 configuration, the keypad buttons perform the following functions:

Keys	Description	Comment

◀	• moves down to the next item in:
	  ◦ a value list
	  ◦ the same level of the menu structure
	• press to decrease the selected numerical digit by 1 unit
		Use these keys to scroll through setting selections:
		• the "=" sign precedes a factory setting or a user-selected setting
		• the "?" sign precedes available settings.

▶	• moves up to the previous item in:
	  ◦ a value list
	  ◦ the same level of the menu structure
	• press to increase the selected numerical digit by 1 unit	

Keys	Description	Comment
ESC	• moves up one level in the menu structure • closes the fault display and displays the scrolling variable list **Note:** the ESC key does not save any settings.	You may need to press ESC several times to return to the upper level of a menu.

ENTER	• navigate from:
	  • a menu ⇒ the sub-menus
	  • a sub-menu ⇒ the functions
	  • a function ⇒ the settings
		Some menus or sub-menus contain only functions and their settings. Others include functions with many parameters and their settings.

	• confirm and save the displayed setting	When a setting is saved: • the "?" is replaced by "=" and • the saved setting is displayed for 2 seconds, then the display automatically returns to the next highest level
AUX1	Performs motor control commands, as configured.	For example, Run Forward, and Run Slow **Note:** Enabled when Control Mode is Local (terminal strip or HMI). Disabled when Control Mode is Network (see *p. 210*).
AUX2	Performs motor control commands, as configured.	For example, Run Reverse, and Run Fast **Note:** Enabled when Control Mode is Local (terminal strip or HMI). Disabled when Control Mode is Network (see *p. 210*).
STOP	Stops the motor.	Local Stop command.
RESET	Resets the LTM R controller and clears all faults that can be reset.	Local Reset command. **Note:** Behavior of the Reset key depends on Fault Reset Mode (see *p. 254*).

LCD Display (1-to-1)

Overview

In a 1-to-1 configuration, the Magelis® XBTN410 presents two different LCD displays:

LCD mode	Displays	Description
Configuration mode	SysConfig menu	Contains basic configuration settings required for commissioning. Opens at first power-up.
	Main menu	Contains optional settings, read-only statistics, read-only LTM R controller information and service commands. Opens on power-up if: ● SysConfig menu settings have been entered and saved, and ● no fault is active
Presentation mode	HMI display	Contains a scrolling list of dynamically changing values for pre-selected variables.
	Faults and warnings	Contains a description of the most recently occurring fault or warning.

The LCD displays the SysConfig menu until its basic configuration settings have been entered and saved as part of the commissioning process.

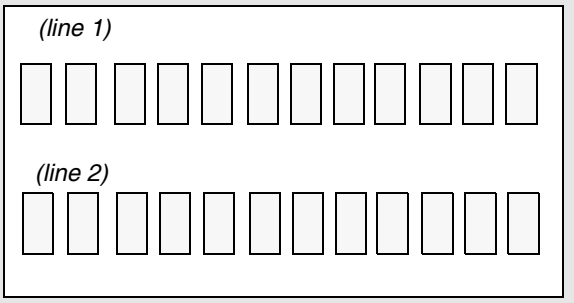
When the SysConfig menu settings have been entered and saved, the LTM R controller clears the Controller System Config Required parameter. Thereafter, the LCD can present any of the other displays.

After the SysConfig settings have been entered and saved, the content of the LCD display can change, as follows:

This LCD screen	Is displayed
Main Menu	● on power-up if no fault exists, or ● by pressing ENTER
HMI display	● automatically, after the Main Menu has been displayed for 10 seconds with no key pressed, or ● by pressing ESC to close a fault or warning display
Fault or warning	automatically, upon the occurrence of a fault or warning

Configuration Mode LCD

In configuration mode, the LCD displays two 12-character lines, as depicted below:



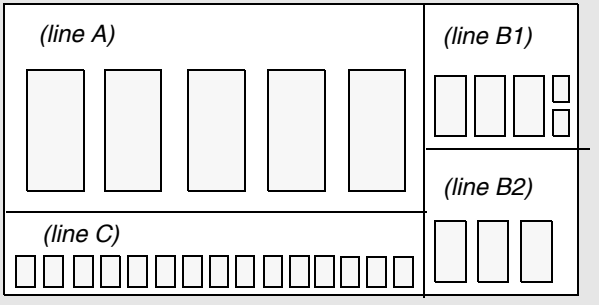
- the top line (line 1) displays the parent—or higher level—menu, sub-menu or parameter
- the bottom line (line 2) displays a related child—or lower level—sub-menu, parameter, or setting.

See *p. 357* for information about navigating the menu structure in configuration mode.

See *p. 358* for information about editing values.

Presentation Mode LCD

In presentation mode, the LCD display contains 4 sections, as depicted below:



line A 5 characters maximum
line B1 3 characters maximum, plus up to 2 icons indicating the control source
line B2 3 characters maximum
line C 15 characters maximum; contains 2 pieces of information:
1 left justified, 1 right justified

In presentation mode, there are 2 HMI displays:

- HMI display
- fault and warning display

All presentation mode displays are read-only.

Control Source Icons

When the HMI is in presentation mode, it displays the current control source–in 1 or 2 icons–located in the upper right corner of the LCD, as follows:

When the control source is...	LCD displays the icon(s)...
local	L
remote (network)	R

See *p. 381* and *p. 387* for examples of the LCD displaying control source icons.

Scrolling Variable List

The LCD uses the presentation mode LCD to display a scrolling list of dynamically changing parameter values when there is no active fault or warning, and the LTM R controller state is:

- Not Ready state
- Ready state
- Start state
- Run state

For a description of LTM R controller states, see *p. 214*.

The scrolling variable list can contain the following information:

Line	Displays	Values	Description
A	Motor state	OFF	The motor is Off.
		Wait	The motor is Off and awaits completion of one or more of the following: ● Load shed ● Rapid cycle lockout ● Counting by another timeout (e.g. thermal time to restart)
		START	Motor is in start cycle
		Run	Start cycle complete
		Run1	Step 1, 2-step operating mode
		Run2	Step 2, 2-step operating mode
		Fwd	Forward, reverser operating mode
		Rev	Reverse, reverser operating mode
		STOP	Stop command issued, motor still running above On current level
		Slow	Low speed, 2-speed operating mode
		Fast	High speed, 2-speed operating mode
		WARN	Warning event detected
		FAULT	Fault event detected
	Parameter value	Parameter-specific	Displays the values of parameters added to the HMI display.
	LTM R controller outputs state	1, 2, 3, 4, 5, 6 or x	The number (1-6) of each active logic output on the LTM R controller. An "x" indicates an inactive output.
	LTM E inputs	LTM E	Indicates the inputs displayed in Line C are expansion module inputs.

Line	Displays	Values	Description
B1	Control wiring	2W	2-wire (maintained) configuration
		3W	3-wire (impulse) configuration
	Unit of measure	Parameter-specific	Displays the unit of the displayed parameter value in the HMI display.
	Outputs	Out	LTM R controller output state is displayed in Line A.
B2	Motor operating mode type	IND	Independent
		REV	Reverser
		2ST	2 step
		2SP	2 speed
		OVL	Overload
	Unit of measure	Parameter-specific	Further describes the unit in Line B1 for displayed parameter values.
	Inputs	In	LTM R controller or expansion module input state is displayed in Line C-left.
	Temp sensor type	NTC	NTC binary
		PTA	PTC analog
		PTC	PTC binary
C - left	LTM R controller state	Ready	Non-fault condition
		Rdy	Warning condition
		RunStart	Start state
		Run	Run state
		Wait	Load shed with active Run command
		Run1	Step 1, 2-step operating mode
		Run2	Step 2, 2-step operating mode
		Fwd	Forward, reverser operating mode
		Rev	Reverse, reverser operating mode
		Stop	Stop command issued, motor still running above On current level
		Slow	Low speed, 2 speed operating mode
		Fast	High speed, 2 speed operating mode
	Inputs state	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or x	The number of each active logic input on the LTM R controller (1-6) or the expansion module (7-10). An "x" indicates an inactive input.

Line	Displays	Values	Description
C - right	(blank)	-	(Applies to scrolling parameter list)
	Transition event	Load Shed	Load shed event occurring
		RapidCycle	Rapid cycle event occurring
		Bump	Bump transition occurring
		Bumpless	Bumpless transition occurring

Fault and Warning Display

When the LTM R controller detects a fault or warning condition, the LCD uses the presentation mode LCD to immediately display a message describing:

- the most recently occurring fault, or
- the most recently occurring warning, if no fault is active

To close the fault or warning message display, click **ESC** to return to the scrolling HMI display.

The fault and warning display contains the following information:

Line	Displays	Value(s)
A	System state	WARN
		FAULT
B1	Fault or Warning Code	See *p. 267* for a list of fault and warning codes and their descriptions.
B2	Operating mode	IND
		REV
		2ST
		2SP
		OVL
C - left	LTM R controller state	Ready
		Rdy)
		Run
		Start
C - right	Fault or warning description	(Protection name)

Navigating the Menu Structure (1-to-1)

Overview

Use the ◀, ▶, ENTER, and ESC buttons to:

- navigate the Sys Config and Main menus
- scroll within a value list
- select a setting in a value list
- exit a value list without making a selection

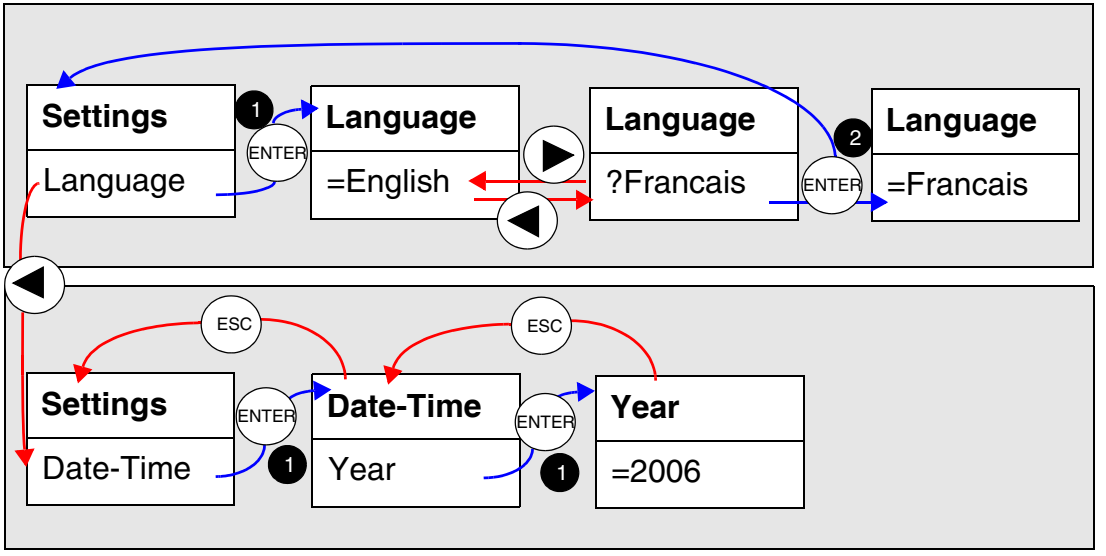
Note that, in the example below, the ENTER button serves 2 different purposes:

1 steps into the next lower level of the menu structure

2 selects an item in a value list, and returns to the previous (higher) level screen

Example

Menu structure navigation example:



Editing Values (1-to-1)

Overview

Use the ◀, ▶, ENTER, and ESC buttons to select and edit settings. There are 2 ways to edit setting values using the Magelis® XBTN410 HMI in a 1-to-1 configuration:

- selecting an item in a value list
- editing a numerical value one digit at a time

Note: Some settings, although expressed as numerical values, are selected in the same manner as an item in a value list. For example, a setting with a value that is expressed in units, but can be incremented or decremented only by tens or hundreds of units, is edited by scrolling through a value list.

Editing any value requires familiarity with the Magelis XBTN410 menu structure, and general navigation principles. For information on menu navigation, see *p. 357*. For information on the menu structure, see *p. 362*.

Selecting Values in a List

The following example describes the selection of a Thermal Overload Trip Class setting:

Step	Description	Screen display
1	Navigate to the Thermal Overload Trip Class parameter	**Th Overload** Trip Class
2	Press the ENTER button to step into the Thermal Overload Trip Class value list. The = sign indicates the displayed value is this parameter's saved setting.	**Trip Class** = 5
3	Press the ◀ button to move to the next value in the list, and press the ▶ button move to the previous value in the list. The? indicates the displayed value is not this parameter's saved setting.	**Trip Class** ? 10
4	When you have displayed the desired value, press the ENTER button to save the setting. The ? changes to a =, indicating the selected value is now this parameter's saved setting.	**Trip Class** = 10
	After displaying the new setting for 2 seconds, the HMI automatically returns to the previous (higher) level screen	**Th Overload** Trip Class

Editing Numerical Values

The following example describes changing the Long Start Fault Timeout setting from its default value of 10 seconds to a new setting of 25 seconds:

Step	Description	Screen display
1	Navigate to the Long Start Fault Timeout parameter.	**Long Start** Fault Time
2	Press the ENTER button to step into the Long Start Fault Timeout setting. The = sign indicates the displayed value is the saved setting.	**Fault Time** = 010 Sec
3	Press the ENTER button again to select the first (left-most) digit for editing. Because 0 is the desired value for the first digit, this digit will not be edited.	**Fault Time** = 0 - - Sec
4	Press the ENTER button again to select the second digit for editing.	**Fault Time** ? 01 - Sec
5	Press the ▶ button once to increment the second digit to the value 2.	**Fault Time** ? 02 - Sec
6	Press the ENTER button to select the third digit for editing.	**Fault Time** ? 020 Sec
7	Press the ▶ button 5 times to increment the second digit to the value 5.	**Fault Time** ? 025 Sec

Step	Description	Screen display
8	After you have entered the new value, press the ENTER button to save the setting. The? changes to a =, indicating the edited value is now this parameter's saved setting.	**Fault Time** = 025 Sec
	After displaying the new setting for 2 seconds, the HMI returns to the previous (higher) level screen	**Long Start** Fault Time

Menu Structure (1-to-1)

Overview

In a 1-to-1 configuration, the Magelis® XBTN410 HMI menu structure includes two configurable menus:

- Sys Config menu
- Main menu

Each menu consists of up to 7 levels of nested parameters. When using the Magelis XBTN410 HMI to navigate to an editable setting or to a read-only value, you must be aware of the menu structure and the location of your destination parameter.

Sys Config Menu

The Sys Config menu:

- opens on first power-up of the LTM R controller
- contains basic settings for operating the LTM R controller, expansion module, and equipment
- closes after its settings are saved

The Sys Config menu is configured as part of the commissioning process. For information on the Sys Config menu, see *p. 327*.

Main Menu

The Main menu:

- appears on power-up of the LTM R controller after the Sys Config menu settings have been saved, if no fault or warning is active
- contains optional configuration settings for the LTM R controller, expansion module and equipment
- closes if no key is pressed within 10 seconds
- re-opens by pressing the **ENTER** key

If the motor is running when the LCD displays the Main menu, some parameters cannot be re-configured and some commands cannot be executed, including:

- Load CT Ratio
- Motor Operating Mode
- Fault Reset Mode (during a fault condition)
- Clear All Command.

Saving Settings

Only configurable parameter settings—the Sys Config menu parameters and the Main menu's Settings sub-menu parameters—can be saved to a file and subsequently downloaded to a replacement LTM R controller. Use PowerSuite™ software to save and download settings.

The Main menu's Statistics, Services, and Product ID sub-menus are not saved and therefore cannot be downloaded to a replacement LTM R controller.

Main Menu (1-to-1)

Overview

In a 1-to-1 configuration, the HMI displays a Main menu that consists of 4 second-level sub-menus, each with up to 3 additional levels of sub-menus. The 4 second-level sub-menus are displayed below:

Level 1	Level 2	Contains
Main Menu	Settings	Configurable settings for all parameters, plus HMI display selections. For a list of Settings sub-menu parameters, see the following topic.
	Statistics	A read-only history of all measured statistics, including motor operation, faults and counters. For a list of Statistics sub-menu parameters, see *p. 371*.
	Services	Executable operating commands including self-test, clear statistics, and password. For a description of the Services commands, see *p. 382*.
	Product ID	A read-only description of the LTM R controller, expansion module, and network module. For a list of Product ID sub-menu parameters, see *p. 378*.

Main Menu - Settings (1-to-1)

Settings menu

The Settings sub-menu is the first selection in Level 2 of the Main menu. The Settings menu contains the following Level 3 sub-menus:

- Language
- Date-Time
- Motor
- Local Control
- Transfer Mode
- Fault Reset
- Current
- Voltage
- Power
- Load Shed
- Diagnostics
- Lock Outs
- Network Port
- HMI Port
- HMI Display

All of the settings sub-menus are described below, except for the HMI Display. For information on the use and contents of the HMI Display sub-menu see *p. 379*.

Language, and Date-Time

The Language and Date-Time sub-menus contain the following editable parameters:

Level 3	Level 4	Level 5	Parameter name / reference
Language			HMI Language Setting
Date-Time	Year		Date And Time Setting
	Month		
	Day		
	Hour		
	Minutes		
	Seconds		

Motor

The Motor sub-menu contains the following editable parameters:

Level 3	Level 4	Level 5	Parameter name / reference
Motor	Nom Voltage		Motor Nominal Voltage
	Nom Power	kWatts	Motor Nominal Power
		Horsepower	
	Phase Seq		Motor Phases Sequence
	Dir Transit		Control Direct Transition
	Transit Time		Motor Transition Timeout
	2 Step Level		Motor Step 1 To 2 Threshold
	2 Step Time		Motor Step 1 To 2 Timeout
	Aux Fan		Motor Aux Fan Cooled
	Temp Sensor	Fault Enable	Motor Temp Sensor Fault Enable
		Sensor Type	Motor Temp Sensor Type
		Fault Level	Motor Temp Sensor Fault Threshold
		Warn Enable	Motor Temp Sensor Warning Enable
		Warn Level	Motor Temp Sensor Warning Threshold

Local Control, Transfer Mode, and Reset

The Local Control, Transfer Mode, and Fault Reset sub-menus contain the following editable parameters:

Level 3	Level 4	Level 5	Parameter name / reference
Local Control			Control Local Channel Setting
TransferMode			Bumpless Transfer Mode
Fault Reset	Mode		Fault Reset Mode
	Auto Group 1	Attempts	Auto-Reset Attempts Group 1 Setting
		Reset Time	Auto-Reset Group 1 Timeout
	Auto Group 2	Attempts	Auto-Reset Attempts Group 2 Setting
		Reset Time	Auto-Reset Group 2 Timeout
	Auto Group 3	Attempts	Auto-Reset Attempts Group 3 Setting
		Reset Time	Auto-Reset Group 3 Timeout

Current The Current sub-menu contains the following editable parameters:

Level 3	Level 4	Level 5	Parameter name / reference
Current	Th Overload	Fault Enable	Thermal Overload Fault Enable
		Trip Type	Thermal Overload Mode
		%FLC1 or %OC1	Motor Full Load Current Ratio
		%FLC2 or %OC2	Motor High Speed Full Load Current Ratio
		Trip Class	Motor Trip Class
		Aux Fan	Motor Aux Fan Cooled
		Reset Level	Thermal Overload Fault Reset Threshold
		Def O-Time	Thermal Overload Fault Definite Timeout
		Def D-Time	Long Start Fault Timeout
		Warn Enable	Thermal Overload Warning Enable
		Warn Level	Thermal Overload Warning Threshold
		Clr ThEnable	Clear Thermal Capacity Level Command
	Curr Ph Imb	Fault Enable	Current Phase Imbalance Fault Enable
		Fault Level	Current Phase Imbalance Fault Threshold
		FltTimeStart	Current Phase Imbalance Fault Timeout Starting
		FltTimeRun	Current Phase Imbalance Fault Timeout Running
		Warn Enable	Current Phase Imbalance Warning Enable
		Warn Level	Current Phase Imbalance Warning Threshold

Level 3	Level 4	Level 5	Parameter name / reference
Current (continued)	Curr Ph Loss	Fault Enable	Current Phase Loss Fault Enable
		Fault Time	Current Phase Loss Fault Timeout
		Warn Enable	Current Phase Loss Warning Enable
	Curr Ph Rev	Fault Enable	Current Phase Reversal Fault Enable
	Long Start	Fault Enable	Long Start Fault Enable
		Fault Level	Long Start Fault Threshold
		Fault Time	Long Start Fault Timeout
	Jam	Fault Enable	Jam Fault Enable
		Fault Level	Jam Fault Threshold
		Fault Time	Jam Fault Timeout
		Warn Enable	Jam Warning Enable
		Warn Level	Jam Warning Threshold
	UnderCurrent	Fault Enable	Undercurrent Fault Enable
		Fault Level	Undercurrent Fault Threshold
		Fault Time	Undercurrent Fault Timeout
		Warn Enable	Undercurrent Warning Enable
		Warn Level	Undercurrent Warning Threshold
Current (continued)	OverCurrent	Fault Enable	Overcurrent Fault Enable
		Fault Level	Overcurrent Fault Threshold
		Fault Time	Overcurrent Fault Timeout
		Warn Enable	Overcurrent Warning Enable
		Warn Level	Overcurrent Warning Threshold
	Ground Curr	Fault Enable	Ground Current Fault Enable
		Gr CT Mode	Ground Current Mode
		Fault Level	External Ground Current Fault Threshold
		Fault Time	External Ground Current Fault Timeout
		Flt AftStart	Ground Current Fault After Starting
		Warn Enable	Ground Current Warning Enable
		Warn Level	External Ground Current Warning Threshold
		WarnAftStart	Ground Current Warning After Starting

Voltage The Voltage sub-menu contains the following editable parameters:

Level 3	Level 4	Level 5	Parameter name / reference
Voltage	Volt Ph Imb	Fault Enable	Voltage Phase Imbalance Fault Enable
		Fault Level	Voltage Phase Imbalance Fault Threshold
		FltTimeStart	Voltage Phase Imbalance Fault Timeout Starting
		FltTimeRun	Voltage Phase Imbalance Fault Timeout Running
		Warn Enable	Voltage Phase Imbalance Warning Enable
		Warn Level	Voltage Phase Imbalance Warning Threshold
	Volt Ph Loss	Fault Enable	Voltage Phase Loss Fault Enable
		Fault Time	Voltage Phase Loss Fault Timeout
		Warn Enable	Voltage Phase Loss Warning Enable
	Volt Ph Rev	Fault Enable	Voltage Phase Reversal Fault Enable
	UnderVoltage	Fault Enable	Undervoltage Fault Enable
		Fault Level	Undervoltage Fault Threshold
		Fault Time	Undervoltage Fault Timeout
		Warn Enable	Undervoltage Warning Enable
		Warn Level	Undervoltage Warning Threshold
Voltage (continued)	OverVoltage	Fault Enable	Overvoltage Fault Enable
		Fault Level	Overvoltage Fault Threshold
		Fault Time	Overvoltage Fault Timeout
		Warn Enable	Overvoltage Warning Enable
		Warn Level	Overvoltage Warning Threshold

Power, Load Shed, Diagnostics, and Lock Outs

The Voltage and Load Shed sub-menus contain the following editable parameters:

Level 3	Level 4	Level 5	Parameter name / reference
Power	UnderPower	Fault Enable	Underpower Fault Enable
		Fault Level	Underpower Fault Threshold
		Fault Time	Underpower Fault Timeout
		Warn Enable	Underpower Warning Enable
		Warn Level	Underpower Warning Threshold
	OverPower	Fault Enable	Overpower Fault Enable
		Fault Level	Overpower Fault Threshold
		Fault Time	Overpower Fault Timeout
		Warn Enable	Overpower Warning Enable
		Warn Level	Overpower Warning Threshold
Power (continued)	Under PF	Fault Enable	Under Power Factor Fault Enable
		Fault Level	Under Power Factor Fault Threshold
		Fault Time	Under Power Factor Fault Timeout
		Warn Enable	Under Power Factor Warning Enable
		Warn Level	Under Power Factor Warning Threshold
	Over PF	Fault Enable	Over Power Factor Fault Enable
		Fault Level	Over Power Factor Fault Threshold
		Fault Time	Over Power Factor Fault Timeout
		Warn Enable	Over Power Factor Warning Enable
		Warn Level	Over Power Factor Warning Threshold
Load Shed	Fault Enable		Load Shedding Enable
	Fault Level		Load Shedding Threshold
	Fault Time		Load Shedding Timeout
	Restart Level		Load Shedding Restart Threshold
	Restart Time		Load Shedding Restart Timeout
Diagnostics	DiagFault	Fault Enable	Diagnostic Fault Enable
		Warn Enable	Diagnostic Warning Enable
Wiring	WiringFlt	Fault Enable	Wiring Fault Enable
Lock Outs	RpdCycl time		Rapid Cycle Lockout Timeout

Network Port, and HMI Port

The Network Port and HMI Port sub-menus contain the following editable parameters:

Level 3	Level 4	Level 5	Parameter name / reference
Network Port	Address		Network Port Address Setting
	Baud Rate		Network Port Baud Rate Setting
	Parity		Network Port Parity Setting
	Config Ctrl		Config Via Network Port Enable
	Comm Loss	Fault	Network Port Fault Enable
		Fallback	Network Port Fallback Setting
		Warning	Network Port Warning Enable
HMI Port	Address		HMI Port Address Setting
	Baud Rate		HMI Port Baud Rate Setting
	Parity		HMI Port Parity Setting
	Config Ctrl	HMI Keypad	Config Via HMI Keypad Enable
		HMI Eng Tool	Config Via HMI Engineering Tool Enable
	Comm Loss	Fault	HMI Port Fault Enable
		Fault Time	Network Port Comm Loss Timeout
		Fallback	HMI Port Fallback Setting
		Warning	HMI Port Warning Enable

HMI Display

Use the HMI Display sub-menu to add items to the scrolling display of dynamically changing parameter values. For information about using this feature, see *p. 379*.

Main Menu - Statistics (1-to-1)

Statistics menu

The Statistics sub-menu is the second selection in Level 2 of the Main menu. The Statistics menu contains the following Level 3 sub-menus:

- History
- Counters
- Fault n-0
- Fault n-1
- Fault n-2
- Fault n-3
- Fault n-4

History and Counters

The History and Counters sub-menus contain the following read-only parameters:

Level 3	Level 4	Level 5	Parameter name / reference
History	CntlrTempMax		Controller Internal Temperature Max
	Oper Time		Operating Time
	Motor Starts		Motor Starts Count
	LO1 Starts		Motor LO1 Starts Count
	LO2 Starts		Motor LO2 Starts Count
	LastStartDur		Motor Last Start Duration
	LastStrtCurr		Motor Last Start Current Ratio
Counters	All Faults		Faults Count
	All Warnings		Warnings Count
	Auto-Resets		Auto-Reset Count
	Protection	Th Ovld Flt	Thermal Overload Faults Count
		Th Ovld Warn	Thermal Overload Warnings Count
		TempSens Flt	Motor Temp Sensor Faults Count
		Curr Imb Flt	Current Phase Imbalance Faults Count
		C PhLossFlt	Current Phase Loss Faults Count
		LongStartFlt	Long Start Faults Count
		Jam Fault	Jam Faults Count
		UnderCurrFlt	Undercurrent Faults Count
		OverCurrFlt	Overcurrent Faults Count
		GroundFault	Ground Current Faults Count
		VoltPhImbFlt	Voltage Phase Imbalance Faults Count

Level 3	Level 4	Level 5	Parameter name / reference
Counters (continued)	Protection (continued)	V PhLossFlt	Voltage Phase Loss Faults Count
		UnderVoltFlt	Undervoltage Faults Count
		OverVoltFlt	Overvoltage Faults Count
		UnderPowFlt	Underpower Faults Count
		OverPowFlt	Overpower Faults Count
		Under PF Flt	Under Power Factor Faults Count
		Over PF Flt	Over Power Factor Faults Count
	Diagnostic	Diag Flts	Diag Faults Count
	Wiring	WiringFlt	Wiring Faults Count
	LoadShedding	Load Sheds	Load Sheddings Count
	Comm	HMI Loss Flt	HMI Port Faults Count
		Ntwk Int Flt	Network Port Internal Faults Count
		NtwkCnfg Flt	Network Port Config Faults Count
		NtwkPort Flt	Network Port Faults Count
	Internal	Cntrlr IntFlt	Controller Internal Faults Count
		InterPortFlt	Internal Port Faults Count

Fault Statistics

The LTM R controller retains a statistical snapshot taken the instant each of the last 5 faults occurred. The most recent fault is n-0. The oldest fault record is n-4.

Fault n-0 records information in the following parameters:

Level 3	Level 4	Parameter name / reference
Fault n-0	Fault Code	Fault Code n-0
	Date	Date And Time n-0
	Time	
	FLC Ratio	Motor Full Load Current Ratio n-0
	FLC Max	Motor Full Load Current Max n-0
	Avg Current	Average Current n-0
	L1 Current	L1 Current n-0
	L2 Current	L2 Current n-0
	L3 Current	L3 Current n-0
	Gr Current	Ground Current n-0
	AvgCurrRatio	Average Current Ratio n-0
	L1CurrRatio	L1 Current Ratio n-0
	L2CurrRatio	L2 Current Ratio n-0
	L3CurrRatio	L3 Current Ratio n-0
	GrCurrRatio	Ground Current Ratio n-0
	Curr Ph Imb	Current Phase Imbalance n-0
	Th Capacity	Thermal Capacity Level n-0
	Avg Volts	Average Voltage n-0
	L3-L1 Volts	L3- L1 Voltage n-0
	L1-L2 Volts	L1- L2 Voltage n-0
	L2-L3 Volts	L2- L3 Voltage n-0
	Volt Ph Imb	Voltage Phase Imbalance n-0
	Frequency	Frequency n-0
	Active Power	Active Power n-0
	Power Factor	Power Factor n-0
	Temp Sensor	Motor Temp Sensor n-0

Fault n-1 records information in the following parameters:

Level 3	Level 4	Parameter name / reference
Fault n-1	Fault Code	Fault Code n-1
	Date	Date And Time n-1
	Time	
	FLC Ratio	Motor Full Load Current Ratio n-1
	FLC Max	Motor Full Load Current Max n-1
	Avg Current	Average Current n-1
	L1 Current	L1 Current n-1
	L2 Current	L2 Current n-1
	L3 Current	L3 Current n-1
	Gr Current	Ground Current n-1
	AvgCurrRatio	Average Current Ratio n-1
	L1CurrRatio	L1 Current Ratio n-1
	L2CurrRatio	L2 Current Ratio n-1
	L3CurrRatio	L3 Current Ratio n-1
	GrCurrRatio	Ground Current Ratio n-1
	Curr Ph Imb	Current Phase Imbalance n-1
	Th Capacity	Thermal Capacity Level n-1
	Avg Volts	Average Voltage n-1
	L3-L1 Volts	L3- L1 Voltage n-1
	L1-L2 Volts	L1- L2 Voltage n-1
	L2-L3 Volts	L2- L3 Voltage n-1
	Volt Ph Imb	Voltage Phase Imbalance n-1
	Frequency	Frequency n-1
	Active Power	Active Power n-1
	Power Factor	Power Factor n-1
	Temp Sensor	Motor Temp Sensor n-1

Fault n-2 records information in the following parameters:

Level 3	Level 4	Parameter name / reference
Fault n-2	Fault Code	Fault Code n-2
	Date	Date And Time n-2
	Time	
	FLC Ratio	Motor Full Load Current Ratio n-2
	FLC Max	Motor Full Load Current Max n-2
	Avg Current	Average Current n-2
	L1 Current	L1 Current n-2
	L2 Current	L2 Current n-2
	L3 Current	L3 Current n-2
	Gr Current	Ground Current n-2
	AvgCurrRatio	Average Current Ratio n-2
	L1CurrRatio	L1 Current Ratio n-2
	L2CurrRatio	L2 Current Ratio n-2
	L3CurrRatio	L3 Current Ratio n-2
	GrCurrRatio	Ground Current Ratio n-2
	Curr Ph Imb	Current Phase Imbalance n-2
	Th Capacity	Thermal Capacity Level n-2
	Avg Volts	Average Voltage n-2
	L3-L1 Volts	L3- L1 Voltage n-2
	L1-L2 Volts	L1- L2 Voltage n-2
	L2-L3 Volts	L2- L3 Voltage n-2
	Volt Ph Imb	Voltage Phase Imbalance n-2
	Frequency	Frequency n-2
	Active Power	Active Power n-2
	Power Factor	Power Factor n-2
	Temp Sensor	Motor Temp Sensor n-2

Fault n-3 records information in the following parameters:

Level 3	Level 4	Parameter name / reference
Fault n-3	Fault Code	Fault Code n-3
	Date	Date And Time n-3
	Time	
	FLC Ratio	Motor Full Load Current Ratio n-3
	FLC Max	Motor Full Load Current Max n-3
	Avg Current	Average Current n-3
	L1 Current	L1 Current n-3
	L2 Current	L2 Current n-3
	L3 Current	L3 Current n-3
	Gr Current	Ground Current n-3
	AvgCurrRatio	Average Current Ratio n-3
	L1CurrRatio	L1 Current Ratio n-3
	L2CurrRatio	L2 Current Ratio n-3
	L3CurrRatio	L3 Current Ratio n-3
	GrCurrRatio	Ground Current Ratio n-3
	Curr Ph Imb	Current Phase Imbalance n-3
	Th Capacity	Thermal Capacity Level n-3
	Avg Volts	Average Voltage n-3
	L3-L1 Volts	L3- L1 Voltage n-3
	L1-L2 Volts	L1- L2 Voltage n-3
	L2-L3 Volts	L2- L3 Voltage n-3
	Volt Ph Imb	Voltage Phase Imbalance n-3
	Frequency	Frequency n-3
	Active Power	Active Power n-3
	Power Factor	Power Factor n-3
	Temp Sensor	Motor Temp Sensor n-3

Fault n-4 records information in the following parameters:

Level 3	Level 4	Parameter name / reference
Fault n-4	Fault Code	Fault Code n-4
	Date	Date And Time n-4
	Time	
	FLC Ratio	Motor Full Load Current Ratio n-4
	FLC Max	Motor Full Load Current Max n-4
	Avg Current	Average Current n-4
	L1 Current	L1 Current n-4
	L2 Current	L2 Current n-4
	L3 Current	L3 Current n-4
	Gr Current	Ground Current n-4
	AvgCurrRatio	Average Current Ratio n-4
	L1CurrRatio	L1 Current Ratio n-4
	L2CurrRatio	L2 Current Ratio n-4
	L3CurrRatio	L3 Current Ratio n-4
	GrCurrRatio	Ground Current Ratio n-4
	Curr Ph Imb	Current Phase Imbalance n-4
	Th Capacity	Thermal Capacity Level n-4
	Avg Volts	Average Voltage n-4
	L3-L1 Volts	L3- L1 Voltage n-4
	L1-L2 Volts	L1- L2 Voltage n-4
	L2-L3 Volts	L2- L3 Voltage n-4
	Volt Ph Imb	Voltage Phase Imbalance n-4
	Frequency	Frequency n-4
	Active Power	Active Power n-4
	Power Factor	Power Factor n-4
	Temp Sensor	Motor Temp Sensor n-4

Main Menu - Product ID (1-to-1)

Product ID menu

The Product ID sub-menu is the fourth selection in Level 2 of the Main menu. The Product ID menu contains information about the LTM R controller, expansion module and network communications module in the following Level 3 sub-menus:

- LTM R controller
- Expansion module
- Network

LTM R Controller, Expansion Module, Network Sub-menus

The Controller, Expansion Module, and Network sub-menus contain the following read-only parameters:

Level 3	Level 4	Parameter name / reference
Controller	Comm Ref	Controller Commercial Reference
	Firmware	Controller Firmware Version
	CurrentRange	LTM R controller amperage
	Control Volt	LTM R controller voltage
	Digital I/O	The number of logic inputs and logic outputs
Exp Module	Comm Ref	Expansion Commercial Reference
	Firmware	Expansion Firmware Version
	Control Volt	LTM R controller voltage
	Digital I/O	The number of logic inputs
	Ready?	The operational status of the expansion module
Network	Protocol	Network Port Commercial Reference
	Firmware	Network Port Firmware Version

Monitoring Using the Scrolling HMI Display (1-to-1)

Overview

Use the LCD display in presentation mode to present a scrolling list of parameters and their dynamically changing values.

To use this feature:

- add parameters to the scrolling list in the HMI Display sub-menu
- monitor the scrolling list using the LCD display.

HMI Display

Use the HMI Display sub-menu to add items to the scrolling display of dynamically changing parameter values. Use **Display All** to add all items in a group. The HMI Display sub-menu contains the following selections:

Level 3	Level 4	Level 5	Parameter name / reference
HMI Display	Contrast	Fault Enable	HMI Display Contrast Setting
	Language	Fault Level	HMI Language Setting
	Display All?		Selects all HMI display items.
	Status	Display All	Selects all Status items.
		Date	HMI Display Date Enable
		Time	HMI Display Time Enable
		Frequency	HMI Display Frequency Enable
		Start Per Hour	HMI Display Starts Per Hour Enable
		Last Fault	HMI Display Last Fault Enable
		I/O Status	HMI Display IO Status Enable
	Th Overload	Display All	Selects all Thermal Overload items.
		Th Capacity	HMI Display Thermal Capacity Level Enable
		Time To Trip	HMI Display Time To Trip Enable
		Definite OC%	HMI Display Definite Overcurrent % Enable

Level 3	Level 4	Level 5	Parameter name / reference
HMI Display (continued)	Current	Display All	Selects all Current items.
		Avg Current	HMI Display Average Current Enable
		L1 Current	HMI Display L1 Current Enable
		L2 Current	HMI Display L2 Current Enable
		L3 Current	HMI Display L3 Current Enable
		AvgCurrRatio	HMI Display Average Current Ratio Enable
		L1CurrRatio	HMI Display L1 Current Ratio Enable
		L2CurrRatio	HMI Display L2 Current Ratio Enable
		L3CurrRatio	HMI Display L3 Current Ratio Enable
		Curr Ph Imb	HMI Display Current Imbalance Enable
		Max Curr Phase	HMI Display Max Current Phase Enable
		Ground Curr	HMI Display Ground Current Enable
HMI Display (continued)	Voltage	Display All	Selects all Voltage items.
		Avg Voltage	HMI Display Average Voltage Enable
		L1-L2 Volts	HMI Display L1-L2 Voltage Enable
		L2-L3 Volts	HMI Display L2-L3 Voltage Enable
		L3-L1 Volts	HMI Display L3-L1 Voltage Enable
		Volt Ph Imb	HMI Display Voltage Phase Imbalance Enable
	Power	Display All	Selects all Power items.
		Power Factor	HMI Display Power Factor Enable
		Active Power	HMI Display Active Power Enable
		React Power	HMI Display Reactive Power Enable
		PowerConsump	HMI Display Power Consumption Enable
	Temp Sensor		HMI Motor Temp Sensor Enable

Scrolling Parameter List

The LCD display automatically presents a scrolling list of parameters and their dynamically changing values if:

- there is no fault or warning, and
- parameters have been selected in the HMI Display sub-menu.

The scrolling parameter list:

- presents parameters in the same order they appear in the HMI Display sub-menu
- displays each parameter for 2 seconds, then moves to the next parameter
- returns to the first selected parameter in the list after reaching the end of the list.

When a fault or warning occurs, the LCD display presents fault or warning information and suspends the scrolling parameter list. The scrolling parameter list resumes:

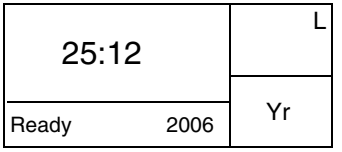
- after the warning condition ceases to exist or the fault is cleared, or
- by pressing the ESC button.

For information on the content of each section of the LCD when displaying the scrolling list of parameters, see *p. 354*.

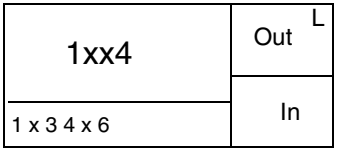
For information on the presentation of faults and warnings, see *p. 386*.

HMI Display Examples

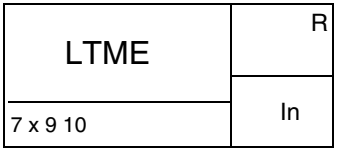
The HMI LCD indicates that the LTM R controller is in local control and Ready state, and displays the day, month and year:



The HMI LCD indicates that the LTM R controller is in local control, and displays logic inputs and logic outputs status, showing that logic outputs O.1 and O.4, and logic inputs I.1, I.3, I.4 and I.6 are active:



The HMI LCD indicates that the LTM R controller is in remote control, and the LTM E expansion module logic inputs I.7, I.9 and I.10 are active:



Main Menu - Services (1-to-1)

Services menu

The Services sub-menu is the third selection in Level 2 of the Main menu. The Services menu contains the following service commands:

- Self Test
- Go to Sys Config
- Clear
- HMI Password

Menu Structure

The Maintenance, Clear, and HMI Password sub-menus contain the following editable parameters and executable commands:

Level 3	Level 4	Level 5	Level 6	Parameter name / reference
Maintenance	Self Test			Self Test Command
	Go to SysCfg			Controller System Config Required
Clear	All		Confirm	Clear All Command
	CntlSettings		Confirm	Clear Controller Settings Command
	NtwkSettings		Confirm	Clear Network Port Settings Command
	Statistics		Confirm	Clear Statistics Command
	Th Cap Level		Confirm	Clear Thermal Capacity Level Command
HMI Password	Password		Confirm	HMI Keypad Password

Self Test

Use the self test command to perform, in sequence, a watchdog check and a RAM check. For more information on the self test function, see *p. 503*.

Executing a self test sets the value of the Self Test Command parameter to 1. After the self test finishes, the value of this parameter returns to 0.

Go to Sys Config

Use the Go to Sys Config sub-menu command to:

- set the Controller System Configuration Required parameter, and
- re-open the Sys Config menu for editing

Note: The motor must be turned off before you can execute the Go to Sys Config sub-menu command.

When you execute the Sys Config command, the LTM R controller returns to its initialized state. The Sys Config menu parameters must be configured before the LTM R controller can resume operations. For information about the Sys Config menu, see *p. 327*.

Clear

The Clear commands perform the following tasks:

Selection	Clears
All[1]	• all editable settings, and restores their values to the factory default settings • all statistics, and resets their values to 0
Settings	all editable settings, and restores their values to the factory default settings
Network Port	only settings for the network port, and restores their values to the factory defaults
Statistics	all statistics, and resets their values to 0
Th Cap Level	the following parameters: • Thermal Capacity Level • Rapid Cycle Lockout Timeout • Thermal Overload Fault Reset See the warning below.
[1] Execution of the Clear All Command returns the SysConfig menu settings to their factory default settings, and requires a re-configuration of the Sys Config menu.	

⚠ WARNING

LOSS OF MOTOR PROTECTION

Clearing the thermal capacity level inhibits thermal protection and can cause equipment overheating and fire. Continued operation with inhibited thermal protection should be limited to applications where immediate restart is vital.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

HMI Password

Use HMI password protection to prevent unauthorized configuration of LTM R controller parameters from the HMI. The password must be an integer from 0000 to 9999. A password value of 0000 disables password protection. Password protection is disabled by default.

The process of entering a password is similar to editing a numerical setting. Editing any value requires familiarity with the Magelis® XBTN410 menu structure, and general navigation principles. For information on menu navigation, see *p. 357*. For information on the menu structure, see *p. 362*.

The following example changes the password from an initial value of 0000 to a password value of 1001:

Step	Description	Screen display
1	Navigate to the HMI Password parameter in the Services menu.	**HMI Password** Change Pswd
2	Press the ENTER button to step into the Password setting. The value 0000 appears by default, and is not necessarily the active password.	**Change Pswd** = 0000
3	Press the ENTER button again to select the first (left-most) digit for editing.	**Change Pswd** = 0 * * *
4	Press the ▶ button once to increment the first digit to the value 1. The = sign changes to ?, indicating the value is being edited.	**Change Pswd** ? 1 * * *
5	Press the ENTER button to move to the second digit for editing. Because this digit will be 0, no further editing is required. Note: Any digit not the focus of editing is hidden and displayed as an asterisk.	**Change Pswd** ? * 0 * *

Step	Description	Screen display
6	Press the ENTER button to move to the third digit for editing. Because this digit also will be 0, no further editing is required.	**Change Pswd** ? * * 0 *
7	Press the ENTER button to move to the fourth digit for editing.	**Change Pswd** ? * * * 0
8	Press the ▶ button once to increment the first digit to the value 1. The = sign changes to ?, indicating the value is being edited.	**Change Pswd** ? * * * 1
9	Press the ENTER button to complete the first entry of the new password. The LCD displays the screen for confirming the new password.	**Confirm Pswd** = 0000
10	Repeat steps 3 through 9. When the new password is confirmed, the LCD returns to the previous (higher) level screen.	**HMI Password** Change Pswd

Fault Management (1-to-1)

Overview

When a warning or fault occurs, the HMI LCD display:

- suspends the scrolling parameter list and displays a description of the fault or warning
- displays a fault, if both a fault and warning are active
- shows the most recent fault or warning, if multiple faults or multiple warnings are active

When a fault or warning occurs, display of the scrolling parameter list is suspended until:

- the fault or warning is resolved, or
- the **ESC** key is pressed.

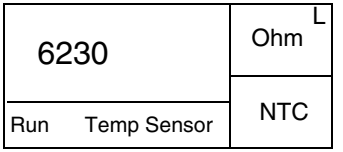
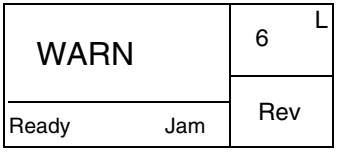
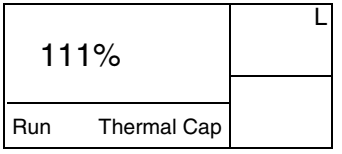
Note: At any time, you can use the:
- **ENTER** key to suspend the scrolling parameter list and open the Main menu
- **ESC** key to close the Main menu and return to the scrolling parameter list.

Fault and Warning Codes

When the HMI displays a fault or warning, it includes both the name and numeric code for the fault or warning. For a description of fault and warning codes, see *p. 267*.

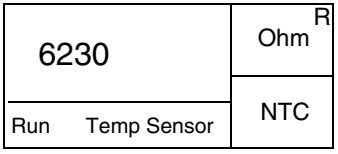
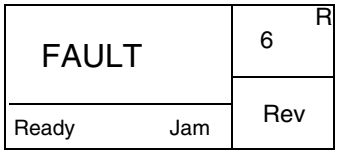
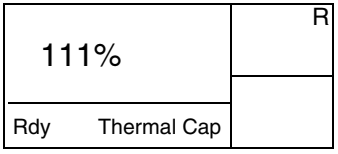
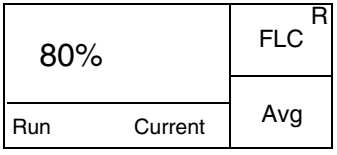
Warning Example

The following is an example of the sequence of screens displayed in response to a Jam warning:

Step	Description	LCD Displays
1	LCD display is scrolling the configurable parameter list. Note that the LTM R controller is in local control mode:	
2	Occurrence of a Jam warning	
3	Jam warning (warning code = 6) is displayed. The warning screen persists until the underlying Jam condition is cleared:	
4	In this case, the measured current value falls below the Jam Warning Threshold setting.	
5	The LCD display resumes scrolling the configurable parameter list:	

Fault Example

The following is an example of the sequence of screens displayed in response to a Jam fault:

Step	Description	LCD Displays
1	LCD display is scrolling the configurable parameter list. Note that the LTM R controller is in remote control mode:	
2	Occurrence of a Jam fault	
3	Jam fault (fault code = 6) is displayed. The fault screen persists until the underlying Jam condition is cleared and fault reset:	
4	In this case, the measured current value falls below the Jam Fault Threshold setting.	
5	Reset command is executed.	
6	The LCD display resumes scrolling the configurable parameter list in Ready state:	
7	A Start command is executed and the LCD display resumes scrolling in Run state:	

HMI Keypad Control (1-to-1)

Overview

In a 1-to-1 configuration, the functionality of the Stop and Reset buttons remain constant, whereas the functionality of the HMI keypad Aux1 and Aux2 keys depends on the:

- selected operating mode, and
- control wiring.

Remember that the HMI keypad commands the LTM R controller's logic outputs only when:

- logic input I.6 is inactive, and
- Control Local Channel Setting parameter is set to **Local HMI**.

Stop, Reset

The functions of the following keys do not vary according to the operating mode selection in a properly wired configuration:

Key	Function
STOP	Stops the motor.
RESET	Resets the LTM R controller after a fault.

Aux1, Aux2

The functions of the Aux1 and Aux2 buttons typically are configured as follows:

Operating mode	Aux1 function	Aux2 function
2 Speed	Run Slow (O.1)	Run Fast (O.2)
2 Step	Run motor (O.1)	Set bits in memory
Independent	Control O.1	Control O.2
Overload	Set bits in memory	Set bits in memory
Reverser	Run Forward (O.1)	Run Reverse (O.2)

Note: The above key function assignments represent a typical configuration. However, the actual functionality of any function key depends on wiring choices.

The behavior of the Aux1 and Aux2 keypad buttons varies according to the operating mode and wiring configuration, as follows:

Key	Can be used to:
Aux1	• control the closing of the NO O.1 contacts 13-14 to energize the operating of a coil or motor • set a bit in LTM R controller memory but control no logic output.

Aux2	• control the closing of the NO O.2 contacts 23 - 24 to energize either:
	  • another operating coil on the same motor
	  • an operating coil on another motor
	• set a bit in LTM R controller memory but control no logic output.

8.5 Using the Magelis® XBTN410 HMI (1-to-many)

At a Glance

Summary

This section describes how to use the Magelis® XBTN410 HMI to operate up to 8 LTM R controllers, in a 1 HMI to many LTM R controllers (1-to-many) physical configuration.

The 1-to-1 and the 1-to-many physical configurations each presents a unique:

- user interface (LCD display and keypad)
- menu structure

See *p. 348* for instructions on how to use the Magelis XBTN410 HMI to operate a single LTM R controller in a 1-to-1 configuration.

Note: In a 1-to-many physical configuration, the Magelis XBTN410 HMI can operate up to 8 LTM R controllers that have previously been commissioned. To commission an individual LTM R controller, use either:

- the Magelis XBTN410 HMI programmed for 1-to-1 operations, or
- PowerSuite™ software.

What's in this Section?

This section contains the following topics:

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Command Lines (1-to-many)	397
Navigating the Menu Structure (1-to-many)	398
Editing Values (1-to-many)	400
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Menu Structure - Home Page (1-to-many)	406
Menu Structure - All LTM R Controllers and the HMI (1-to-many)	407
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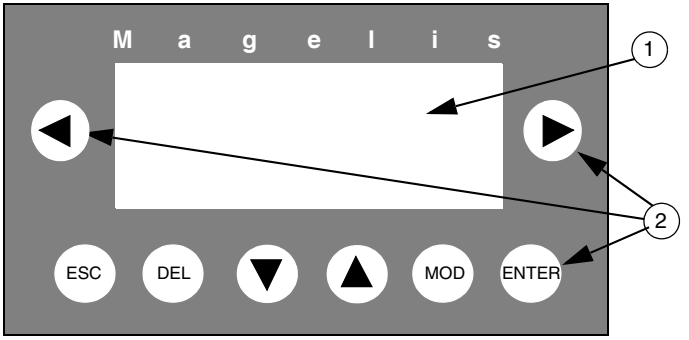
Physical Description (1-to-many)

1-to-many Interface

When a Magelis® XBTN410 is used in a 1-to-many physical configuration, the face of the HMI looks like this:



1 LCD display
2 8 button keypad

1-to-Many Keypad

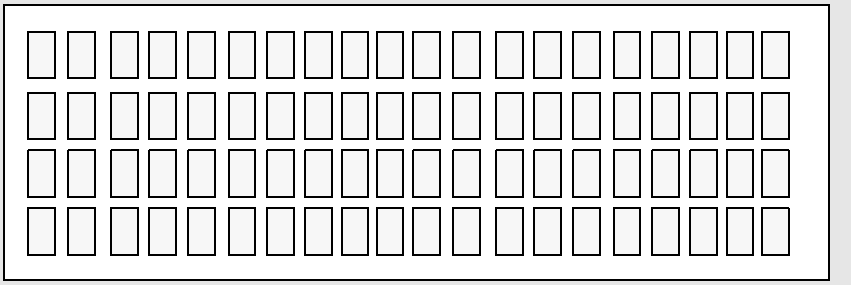
The 1-to-many configuration requires a customized keypad label. Using a blank keypad label, add the names of the 6 bottom buttons to the label. For instructions on creating and installing a customized keypad label, refer to the Telemecanique Magelis Instruction Sheet that ships with the Magelis XBTN410 HMI.

In a 1-to-many configuration, the keypad buttons perform the following functions:

Keys	Use this key to
	• enter the menu structure for a selected LTM R controller at address 1–4 • move to the adjacent left character within a numerical setting value • execute remote reset commands for a selected LTM R controller at address 1–4 • reset statistics to factory defaults for a selected LTM R controller • display the description of another fault, when the LCD displays fault messages
	• enter the menu structure for a selected LTM R controller at address 5–8 • move to a lower level in a LTM R controller menu structure • move to the adjacent right character within a numerical setting value • toggle between alternate values for Boolean settings • execute remote reset commands for a selected LTM R controller at address 5–8 • reset settings to factory defaults for a selected LTM R controller • display the description of another fault, when the LCD displays fault messages
	• scroll down through a page • decrement by 1 the value of the selected digit or setting
	• scroll up through a page • increment by 1 the value of the selected digit or setting
	• select a numeric setting for editing **Note:** after a setting is selected, you can increment or decrement either: • the entire value - or - • a selected digit within the setting.
	• exits the present level in the HMI menu structure and moves up to the next level • exits the selected setting without saving changes.
	• saves changes and exits the selected setting
	• deletes the value of the selected setting **Note:** after deleting a setting value, you can either: • use the arrow keys to input a new value, then click ENTER to save it - or - • click ESC to restore the deleted value.

1-to-Many LCD

In a 1-to-many configuration, the Magelis® XBTN410 HMI presents a flexible LCD that can display up to 4 rows of 20 characters, as follows:



In some cases the LCD displays only 3 text lines, because one line—containing a fault message or page header—is twice the height of normal text.

Pages

The LCD displays pages of text. There are two types of pages:

Page type	Contains	Displayed
Menu structure page	• page header that is twice the height of ordinary LCD text • links to other pages • read-only parameter values • editable parameter settings • function commands	by navigating through the HMI menu structure to the specific page
Fault message page	• a flashing fault message • the number of active faults	• automatically when a fault occurs • by selecting Faults in the Home page

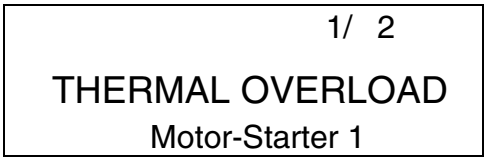
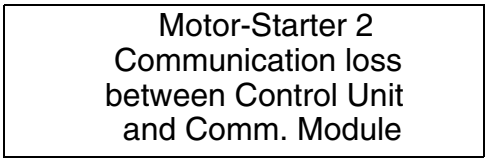
Pages often contain more than 4 lines of text. See *p. 398* for instructions on how to navigate within and between pages.

Page examples

The Home page:

The top 4 lines of the Home page	TeSys T Vx.x Starters currents ▶ Starters status ▶
Use the ▼ button to scroll down and reveal more of this page. **Note:** click on a flashing ▶ to navigate to that page.	Starters status ▶ Remote reset ▶ Faults ▶ Reset to defaults ▶

Fault message pages:

The opening fault message page. **Note:** the fault name "THERMAL OVERLOAD" and the LTM R controller address "Motor-Starter 1" both flash when displayed.	
Click the ▶ button to display additional fault message pages.	
Click the ▼ button to scroll down and reveal more of the Internal Comm Loss fault message.	

Command Lines (1-to-many)

Overview

Use the HMI keypad ◀ and ▶ keys to execute text line commands. A command line is identified by a:

- ▶ at the right end of the text line, or
- ◀ at the left end of the text line

A command can be executed only when its text line has focus. A text line has focus when the ◀ or ▶ at either end of the text line—plus any additional command character—is blinking.

Command Lines

The 1-to-many menu structure presents 4 different kinds of command lines, depending upon the command character—if any—next to the command line arrow, as follows:

Command line characters		Description
Left	**Right**	
◀	▶	Links to a page. With no character next to the blinking arrow, click the: • ◀ keypad button to move to the page indicated by the left arrow • ▶ keypad button to move to the page indicated by the right arrow.
N/A	0 ▶ - or - 1 ▶	Toggle bit commands. With a 0 or a 1 next to the blinking arrow, click the ▶ keypad button to toggle the Boolean setting value.
◀ v	v ▶	Value write commands. With a v next to the blinking arrow, click the: • ◀ keypad button to execute the command indicated by the left arrow • ▶ keypad button to execute the command indicated by the right arrow. For example: • Reset to Defaults: Statistics • Reset to Defaults: Settings • Self-Test
◀ ?	? ▶	Command cannot execute. There is no connection between the HMI and the indicated LTM R controller.

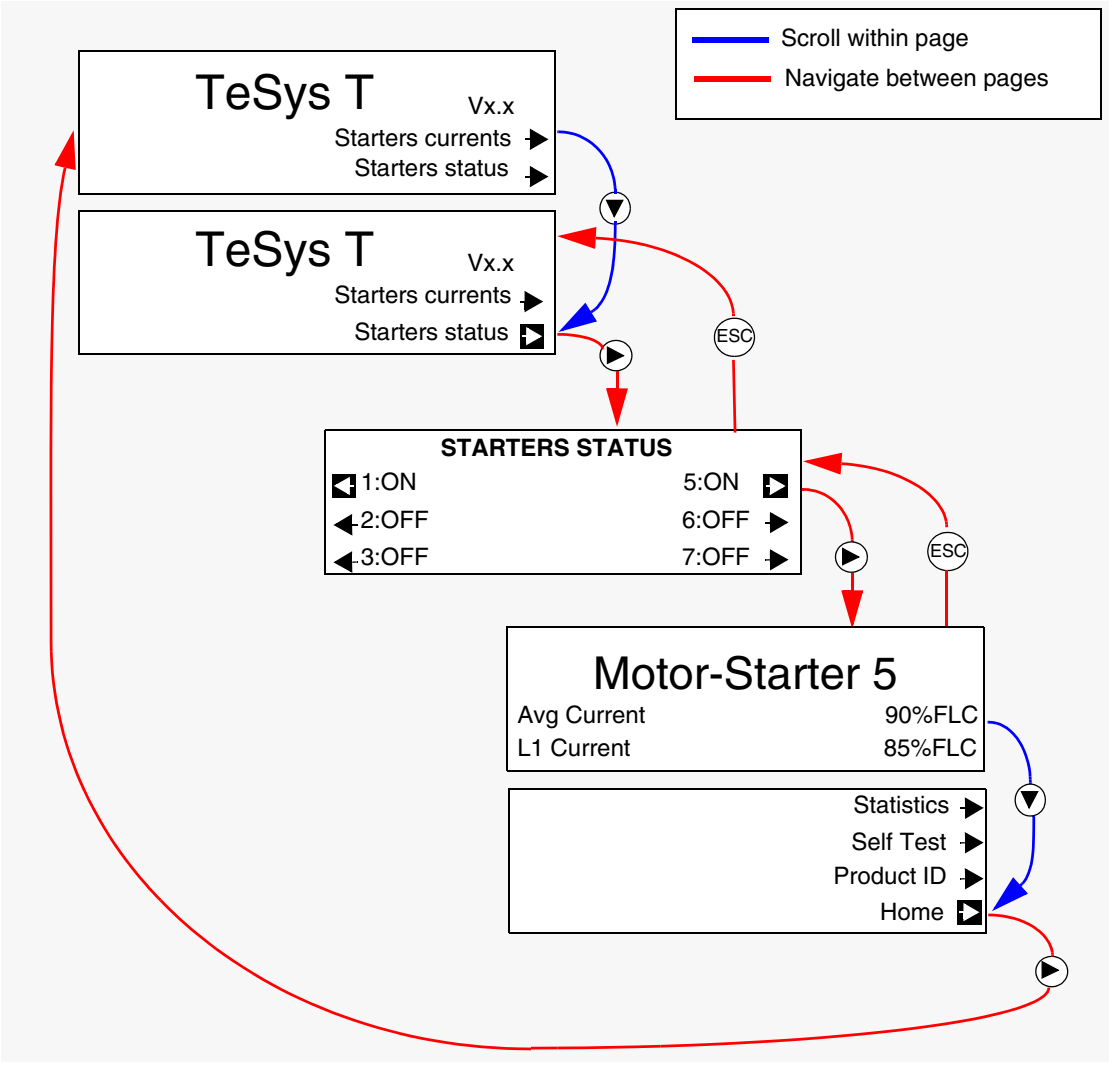
Navigating the Menu Structure (1-to-many)

Overview

Use the HMI keypad ▲, ▼, ◀, ▶ and ESC buttons to:

- scroll within a page
- link to a page in the next, lower level in the menu structure
- return to a page in the next, higher level in the menu structure
- jump to the Home page

Example The following navigation example begins and ends at the Home page:



Editing Values (1-to-many)

Overview

Use the HMI keypad ▲, ▼, ◀, ▶, MOD and ENTER buttons to edit setting values. There are three kinds of editable settings:

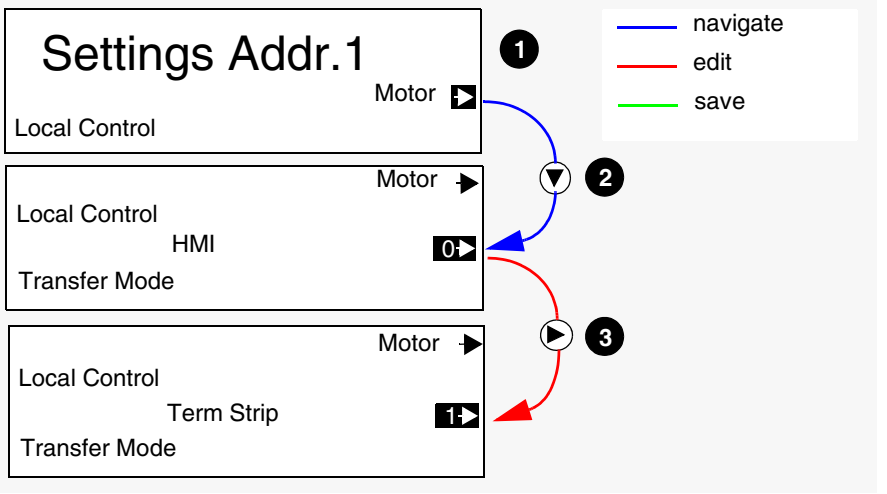
- Boolean
- numeric
- value list

Only settings that are displayed in the LCD can be edited. To display a setting, navigate to the page that contains the setting. With the correct page opened, you may need to scroll down to display the setting.

See *p. 400* for information about navigating the 1-to-many menu structure.

Boolean settings

A Boolean value setting includes a 0 or a 1 next to the ▶ at the right end of the text line. The following example shows you how to select then edit a Boolean value:



1 The Settings page opens with focus at the top line.
2 Click the DOWN button to scroll down to the Local Control setting (HMI). The Boolean value (0) and command line arrow blink, indicating focus.
3 Click the RIGHT arrow to toggle the Local Control setting to Term Strip and the Boolean value to 1.

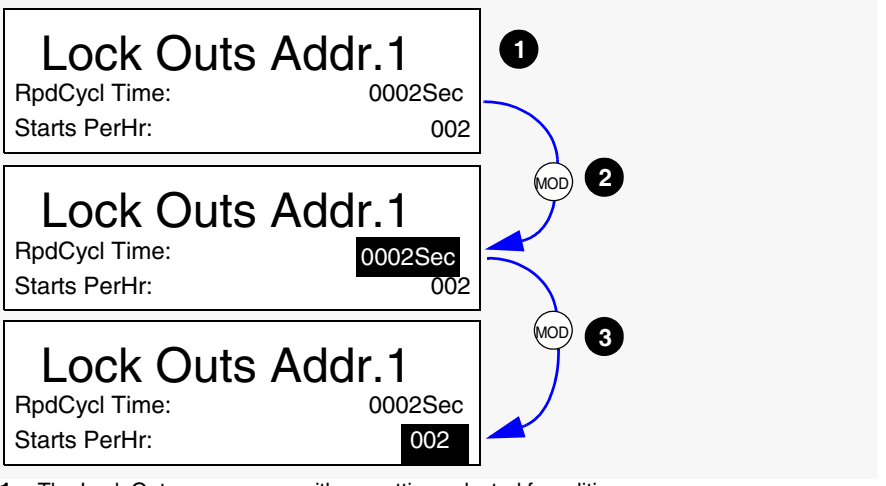
Note: An edited Boolean value is saved when its value changes.

Numeric settings

Numeric value settings are incremented or decremented, and can be edited in 2 ways:

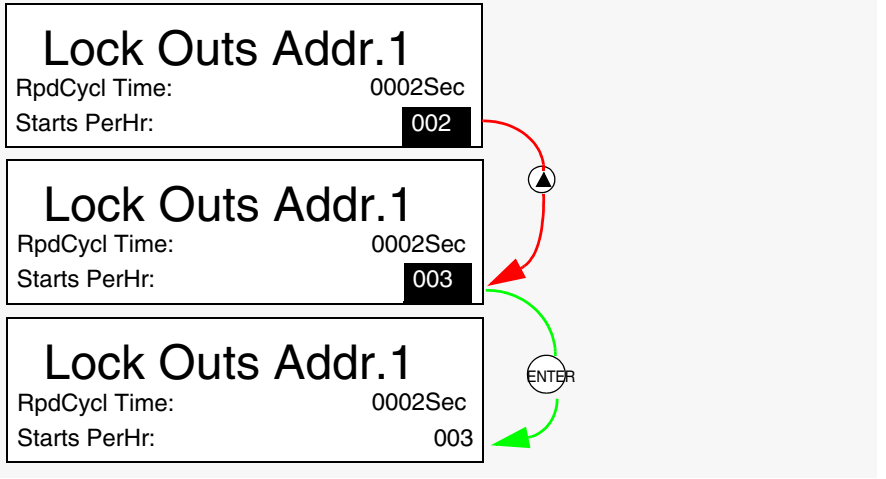
- by selecting the entire setting and then incrementing or decrementing its value
- by selecting individual characters within the setting and then incrementing or decrementing the value of each digit.

Use the MOD button to select the value to be edited, as follows:

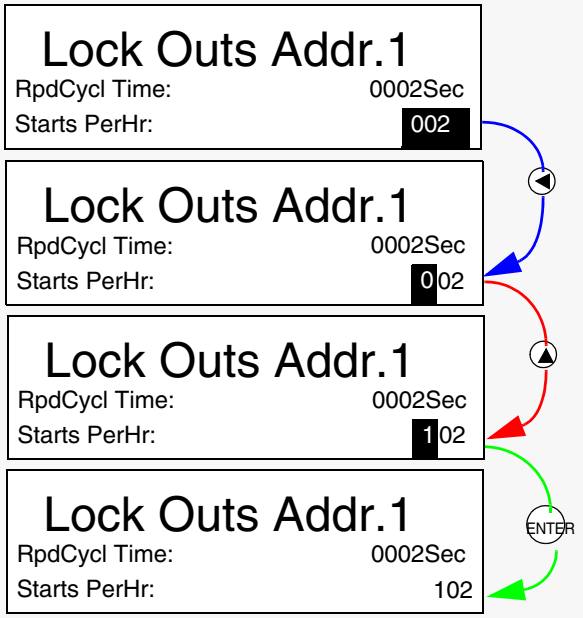


1 The Lock Outs page opens with no setting selected for editing.
2 Click the MOD button once to select the first displayed numerical field for editing.
3 Click the MOD button a second time to select the next displayed numerical field for editing.

After a setting is selected for editing, you can use the ▲ and ▼ buttons to increment or decrement the entire value, then use the ENTER button to save the edit:

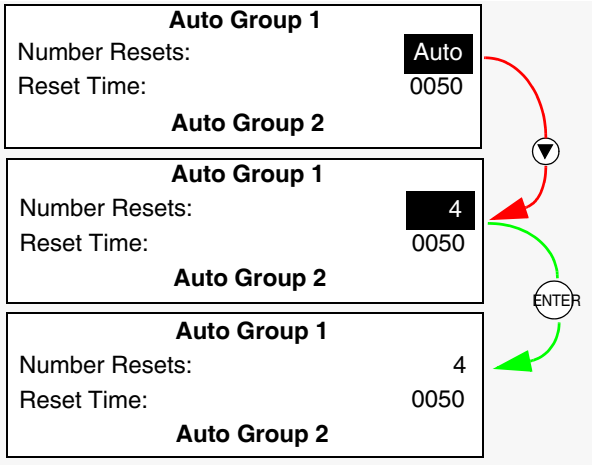


Alternatively, after a setting is highlighted you can use the ◀ and ▶ buttons to select only a single character within a field and edit that character, as follows:



Value List Settings

In a few cases, a setting presents a list of value selections. Selecting a value from the list is very much like incrementing or decrementing the entire value of a numerical setting, as shown below:



Executing a Value Write Command (1-to-many)

Overview

The Magelis® XBTN410 HMI, in 1-to-many configuration provides executable value write commands. A value write command immediately executes a task. The value write command line is identified by either a:

- ◀ v (at the left end of a command line, or)
- v ▶ (at the right end of a command line

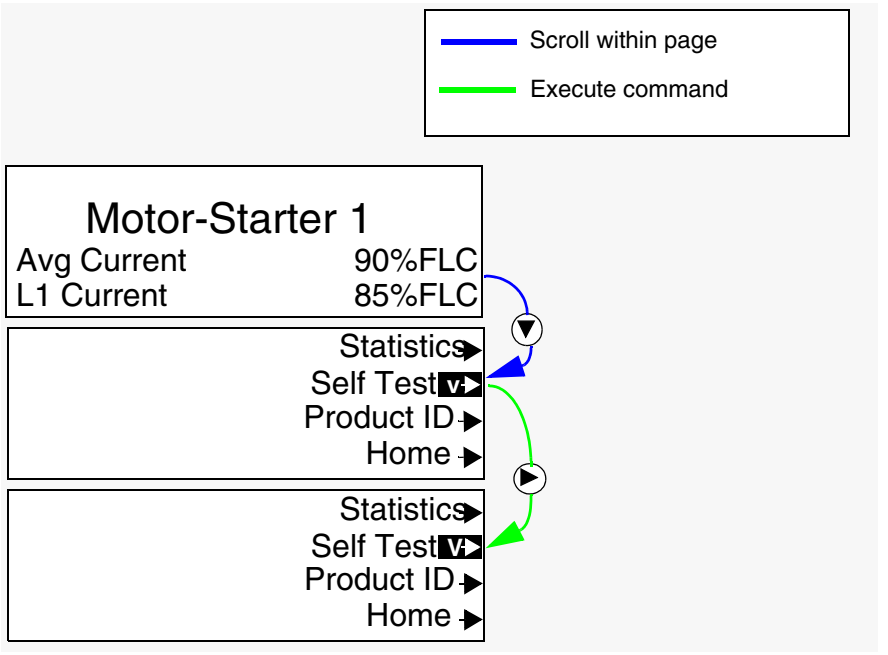
If a value write command is unsuccessful, the HMI displays an error message. If the value write command is successful, no message is displayed.

Value write commands include:

Value write command	Task	Location
Clear Settings	Clears settings and restores defaults.	Reset to Defaults page
Clear Statistics	Clears statistics and restores defaults.	
Self Test	Performs a self-test.	Motor Starter page
Reset - Manual	Enables manual resetting of faults	Reset page
Reset - Remote	Enables remote resetting of faults	
Reset - Automatic	Enables automatic resetting of faults	

Example

Use the ◀ or the ▶ arrow key to execute a value write command. When a value write command executes, the lower case "v" next to the arrow becomes an upper case "V", as shown below, then quickly returns to a lower case "v" after the command executes:



Menu Structure (1-to-many)

Overview

The Magelis® XBTN410 HMI 1-to-many menu structure is hierarchical in its design and consists of 6 levels of individual pages. The upper menu structure levels provide information and commands for the HMI itself and for all LTM R controllers connected to the HMI. The lower menu structure levels provide settings, statistics and commands for a selected LTM R controller.

Menu Structure Outline

The Magelis XBTN410 HMI 1-to-many menu structure presents the following outline of levels and pages:

Level	Pages	Description:
1	Home page	The starting page – navigation to all other pages begins here. Opens by default on start-up when no faults exist.
2	Starters currents page	• Displays average current as a percent of FLC for every LTM R controller. • Provides a link to each LTM R controller's menu structure.
	Starters status page	• Displays operating status (On, Off, Fault) for every LTM R controller. • Provides a link to each LTM R controller's menu structure.
	Fault display pages	Displays a series of pages, each page describing an active fault. Opens automatically when a fault exists.
	Remote reset page	Executable commands for the remote reset of each LTM R controller.
	Reset to defaults page	Executable commands to reset statistics or settings for each LTM R controller.
	XBTN reference page	Describes communication settings, application program file, programming software version, and HMI firmware version.
3	Motor starter page	For a selected LTM R controller: • Displays dynamically changing parameter values • Self Test command • Links to its settings, statistics and Product ID information.
4, 5, 6	Settings page and sub-pages	Contains configurable settings for a selected LTM R controller
	Statistics page and sub-pages	Presents statistics for a selected LTM R controller, including fault n-0 and fault n-1 history.
	Product ID page	LTM R controller and expansion module part and firmware identification.

Menu Structure - Home Page (1-to-many)

Overview

The Home Page opens by default on HMI start-up, when the Magelis® XBTN410 is connected to 1 or more LTM R controllers—all of which are running without faults or warnings.

The Home page is the only page located in level 1 of the Magelis XBTN410 1-to-many menu structure. It is the starting place for navigation to all other levels and pages in the menu structure.

See *p. 398* for instructions on how to scroll through a page and navigate to other pages in the 1-to-many menu structure.

Home Page

The Home page contains the following menu items:

Menu item	Description
TeSys T VX.X	Page header with LTM R controller firmware version.
Starters currents ▶	Links to a page that displays average current and provides links to data and commands for each LTM R controller.
Starters status ▶	Links to a page that displays status (On, Off, Fault) and provides links to data and commands for each LTM R controller.
Faults ▶	Displays a series of fault messages.
Remote Reset ▶	Links to a page that displays the status of each LTM R controller; and provides a reset command for each LTM R controller.
Reset to defaults ▶	Links to a page with commands that reset to factory defaults each LTM R controller's statistics or settings.
XBTN Reference ▶	Links to a page that describes communication speed and parity, programming software and LTM R controller firmware.

Menu Structure - All LTM R Controllers and the HMI (1-to-many)

Overview

Pages located in level 2 of the menu structure contain:

- information and commands for up to 8 connected LTM R controllers, or
- fault information for all LTM R controller, or
- information about the Magelis® XBTN410 HMI

All level 2 menu structure pages are accessible from the Home page.

For information about navigating the 1-to-many menu structure, see *p. 398*.

Starters Currents Page

Use the Starters Currents page to monitor the Average Current Ratio for all connected LTM R controllers, and to navigate to other pages as described below:

Level 2				Description
STARTERS CURRENTS				–
◄	I1=XXXX%	I5=XXXX%	►	Opens the Motor Starter page for the selected LTM R controller (1-8).
◄	I2=XXXX%	I6=XXXX%	►	
◄	I3=XXXX%	I7=XXXX%	►	
◄	I4=XXXX%	I8=XXXX%	►	
		Starters status	►	Opens the Starters Status page.
		Remote reset	►	Opens the Remote Reset page.
		Home	►	Returns to the Home page.

Starters Status Page

Use the Starters Status page to monitor the System On and System Fault status of all connected LTM R controllers, and to navigate to other pages as described below:

Level 2				Description
STARTERS STATUS				–
◄	1:XXX	5:XXX	►	Opens the Motor Starter page for the selected controller (1-8).
◄	2:XXX	6:XXX	►	
◄	3:XXX	7:XXX	►	
◄	4:XXX	8:XXX	►	
		Starters currents	►	Opens the Starters Currents page.
		Remote reset	►	Opens the Remote Reset page.
		Home	►	Returns to the Home page.

Faults Display

The Magelis® XBTN410 HMI displays active faults in a series of pages–1 fault to a page–when:

- a fault occurs, and the display of active faults automatically opens
- you select Faults in the Home page and manually open the display of active faults.

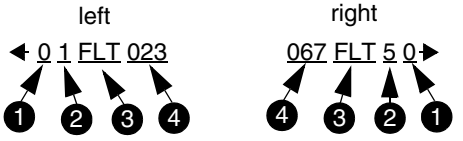
For information about fault management, including the faults display pages, see *p. 424*.

Remote Reset Page

Use the Remote Reset page to remotely execute a Fault Reset Command for a faulted LTM R controller–for controllers with Fault Reset Mode set to Remote, and to navigate to other pages:

Level 2		Description
REMOTE RESET		–
◄ 01FLT023	067FLT50 ►	Executes a Fault Reset Command for the selected LTM R controller (1-8) if remote fault reset is enabled for that controller.
◄ 02FLT034	078FLT60 ►	
◄ 03FLT045	089FLT70 ►	
◄ 04FLT056	090FLT80 ►	
	Starters currents ►	Opens the Starters Currents page.
	Starters status ►	Opens the Starters Status page.
	Home ►	Returns to the Home page.

Each of the first 4 lines of this page provide the following fault reset information at the indicated locations:



1 fault reset bit (not significant)
2 LTM R controller number (1–8)
3 fault status (ON, OFF, FLT)
4 time to reset (seconds)

Reset to Defaults Page

The Reset to Defaults page provides the Clear Statistics Command and the Clear Controller Settings Command for each LTM R controller, as displayed below:

Level 2					Description
RESET TO DEFAULTS					–
◀	STATS	1	SETTINGS	▶	Clears statistics (left arrows) or settings (right arrows) for the selected LTM R controller (1-8), and restores factory defaults.
◀	STATS	2	SETTINGS	▶	
◀	STATS	3	SETTINGS	▶	
◀	STATS	4	SETTINGS	▶	
◀	STATS	5	SETTINGS	▶	
◀	STATS	6	SETTINGS	▶	
◀	STATS	7	SETTINGS	▶	
◀	STATS	8	SETTINGS	▶	

XBTN Reference Page

The XBTN Reference page provides information about the HMI. The following is an example of information displayed in this page:

Level 2		Parameter name / description
XBTN Reference		–
MB Speed=	19200	HMI Port Baud Rate Setting
MB Parity=	Even	HMI Port Parity Setting
LTM_1T8_E_Vx.xx.DOP		file name for the HMI application program
XX/XX/200X	xx:xx:xx	date of the HMI application program file
XBT-L1000=	V 4.42	version of the XBTL1000 software
Firmware=	V 3.1	version of the HMI firmware

Motor Starter Page (1-to-many)

Overview

The Motor Starter page presents information and commands for the LTM R controller that was selected in either the Starters Currents page or the Starters Status page (see *p. 407*).

The Motor Starter page is the only page located in level 3 of the menu structure.

Use the Motor Starter page to:

- monitor dynamically changing current, voltage, and power values for a single, selected LTM R controller
- navigate to editable parameter settings for a LTM R controller
- navigate to read-only statistics and product information for a LTM R controller
- execute the Self Test command for a LTM R controller

For information about navigating the 1-to-many menu structure, see *p. 398*.

Motor Starter Page

The Motor Starter page displays dynamically changing parameter values, and contains the command lines, as follows:

Level 3		Parameter name / Description
Motor Starter 1-8		Page header indicating LTM R controller address (1–8).
Avg Current=	xxxx%FLC	Average Current Ratio
L1 Current=	xxxx%FLC	L1 Current Ratio
L2 Current=	xxxx%FLC	L2 Current Ratio
L3 Current=	xxxx%FLC	L3 Current Ratio
GR Current=	xxxx.x%FLCmin	Ground Current Ratio
Curr Imbalance=	xxx%	Current Phase Imbalance
Th Capacity=	xxxxx%	Thermal Capacity Level
Time To Trip=	xxxxSec	Time To Trip
Avg Voltage=	xxxx%FLCmin	Average Voltage
L1-L2 Voltage=	xxxxxV	L1-L2 Voltage
L2-L3 Voltage=	xxxxxV	L2-L3 Voltage
L3-L1 Voltage=	xxxxxV	L3-L1 Voltage
Volt Imbalance=	xxx%	Voltage Phase Imbalance
Power Factor=	xx.xx	Power Factor
Active Pwr=	xxxx.xkW	Active Power
React Pwr=	xxxx.xkVAR	Reactive Power
Temp Sensor=	xxxx.xΩ	Motor Temp Sensor
	Settings ▶	Links to editable settings for the LTM R controller.
	Statistics ▶	Links to read-only statistics for the LTM R controller.
	Self Test v ▶	Executes the Self Test command. See *p. 503*.
	Product ID ▶	Links to product reference numbers and firmware versions for the LTM R controller and expansion module.
	Home ▶	Returns to the Home page.

Settings (1-to-many)

Overview

The Magelis® XBTN410 HMI provides several pages of editable parameter settings, nested in levels 4, 5 and 6 of the menu structure. The settings page is your starting place for locating and editing settings, including:

- motor
- local control
- transfer mode
- reset (fault)
- current
- voltage
- power
- load shed
- rapid cycle lockouts
- communication loss

The settings page is located in level 4 of the menu structure. To navigate to the settings page, use one of the following paths:

Level	From this page...	Select...
1	Home page	Starters currents, or Starters status
2	Starters Currents page, or Starters Status page	LTM R controller number
3	Motor Starter page	Settings

For information on navigating the 1-to-many menu structure, see *p. 398*.

Motor, Control, and Transfer Settings

Use the settings page to navigate to and edit the following motor, local control and transfer mode settings:

Level 4	Level 5	Parameter name
Settings Addr. 1-8		–
Motor	Nom Power (kW)	Motor Nominal Power (expressed in kW)
	Nom Power (Hp)	Motor Nominal Power (expressed in HP)
	TEMP SENSOR	–
	Fault	Motor Temp Sensor Fault Enable
	Fault Level	Motor Temp Sensor Fault Threshold
	Warn	Motor Temp Sensor Warning Enable
	Warn Level	Motor Temp Sensor Warning Threshold
Local Control		Control Local Channel Setting
Transfer Mode		Bumpless Transfer Mode

Fault Reset Settings

Use the settings page to navigate to and edit the following fault reset settings:

Level 4	Level 5	Parameter name
Settings Addr.1-8		–
Reset	Manual	Fault Reset Mode
	Remote	
	Automatic	
	AUTO GROUP 1	–
	Number Resets	Auto-Reset Attempts Group 1 Setting
	Reset Time	Auto-Reset Group 1 Timeout
	AUTO GROUP 2	–
	Number Resets	Auto-Reset Attempts Group 2 Setting
	Reset Time	Auto-Reset Group 2 Timeout
	AUTO GROUP 3	–
	Number Resets	Auto-Reset Attempts Group 3 Setting
	Reset Time	Auto-Reset Group 3 Timeout

Current Settings From the settings page, you can navigate to and edit the following current settings:

Level 4	Level 5	Level 6	Parameter name
Settings Addr.1-8			**–**
Current	Th Overload	Fault	Thermal Overload Fault Enable
		FLC1-OC1	Motor Full Load Current Ratio
		FLC2-OC2	Motor High Speed Full Load Current Ratio
		Reset Level	Thermal Overload Fault Reset Threshold
		Warn	Thermal Overload Warning Enable
		Warn Level	Thermal Overload Warning Threshold
	Curr Ph Imbal / Loss	CURR PH IMBALANCE	–
		Fault	Current Phase Imbalance Fault Enable
		Fault Level	Current Phase Imbalance Fault Threshold
		FltTimeStart	Current Phase Imbalance Fault Timeout Starting
		FltTimeRun	Current Phase Imbalance Fault Timeout Running
		Warn	Current Phase Imbalance Warning Enable
		Warn Level	Current Phase Imbalance Warning Threshold
		CURR PH LOSS	–
		Fault	Current Phase Loss Fault Enable
		Fault Time	Current Phase Loss Timeout
		Warn	Current Phase Loss Warning Enable
Current (continued)	Curr Ph Reversal	Fault	Current Phase Reversal Fault Enable
	Long Start	Fault	Long Start Fault Enable
		Fault Level	Long Start Fault Threshold
		Fault Time	Long Start Fault Timeout
	Jam	Fault	Jam Fault Enable
		Fault Level	Jam Fault Threshold
		Fault Time	Jam Fault Timeout
		Warn	Jam Warning Enable
		Warn Level	Jam Warning Threshold

Level 4	Level 5	Level 6	Parameter name
Settings Addr.1-8			**–**
Current (continued)	Over / Under Current	OVER CURRENT	–
		Fault	Overcurrent Fault Enable
		Fault Level	Overcurrent Fault Threshold
		Fault Time	Overcurrent Fault Timeout
		Warn	Overcurrent Warning Enable
		Warn Level	Overcurrent Warning Threshold
		UNDER CURRENT	–
		Fault	Undercurrent Fault Enable
		Fault Level	Undercurrent Fault Threshold
		Fault Time	Undercurrent Fault Timeout
		Warn	Undercurrent Warning Enable
		Warn Level	Undercurrent Warning Threshold
Current (continued)	Ground Current	Fault	Ground Current Mode
		GR CT Mode	Ground Current Fault Enable
		IntFltLvl	Internal Ground Current Fault Threshold
		IntFltTime	Internal Ground Current Fault Timeout
		ExtFltLvl	External Ground Current Fault Threshold
		ExtFltTime	External Ground Current Fault Timeout
		Warn	Ground Current Warning Enable
		IntWarnLvl	Internal Ground Current Warning Threshold
		ExtWarnLvl	External Ground Current Warning Threshold

Voltage Settings From the settings page, you can navigate to and edit the following voltage settings:

Level 4	Level 5	Level 6	Parameter name
Settings Addr.1-8			**–**
Voltage	Volt Ph Imbal / Loss	VOLT PH IMBALANCE	–
		Fault	Voltage Phase Imbalance Fault Enable
		Fault Level	Voltage Phase Imbalance Fault Threshold
		FltTimeStart	Voltage Phase Imbalance Fault Timeout Starting
		FltTimeRun	Voltage Phase Imbalance Fault Timeout Running
		Warn	Voltage Phase Imbalance Warning Enable
		Warn Level	Voltage Phase Imbalance Warning Threshold
		VOLT PH LOSS	–
		Fault	Voltage Phase Loss Fault Enable
		Fault Time	Voltage Phase Loss Fault Timeout
		Warn	Voltage Phase Loss Warning Enable
	Volt Ph Reversal	Fault	Voltage Phase Reversal Fault Enable
Voltage (continued)	Over / Under Voltage	OVER VOLTAGE	–
		Fault	Overvoltage Fault Enable
		Fault Level	Overvoltage Fault Threshold
		Fault Time	Overvoltage Fault Timeout
		Warn	Overvoltage Warning Enable
		Warn Level	Overvoltage Warning Threshold
		UNDER VOLTAGE	–
		Fault	Undervoltage Fault Enable
		Fault Level	Undervoltage Fault Threshold
		Fault Time	Undervoltage Fault Timeout
		Warn	Undervoltage Warning Enable
		Warn Level	Undervoltage Warning Threshold

Power Settings

From the settings page, you can navigate to and edit the following power settings:

Level 4	Level 5	Parameter name
Settings Addr.1-8		**–**
Power	OVER POWER	–
	Fault	Overpower Fault Enable
	Fault Level	Overpower Fault Threshold
	Fault Time	Overpower Fault Timeout Starting
	Warn	Overpower Warning Enable
	Warn Level	Overpower Warning Threshold
	UNDER POWER	–
	Fault	Underpower Fault Enable
	Fault Level	Underpower Fault Threshold
	Fault Time	Underpower Fault Timeout
	Warn	Underpower Warning Enable
	Warn Level	Underpower Fault Enable
Power (continued)	OVER POWER FACTOR	–
	Fault	Over Power Factor Fault Enable
	Fault Level	Over Power Factor Fault Threshold
	Fault Time	Over Power Factor Fault Timeout
	Warn	Over Power Factor Warning Enable
	Warn Level	Over Power Factor Warning Threshold
	UNDER POWER FACTOR	–
	Fault	Under Power Factor Fault Enable
	Fault Level	Under Power Factor Fault Threshold
	Fault Time	Under Power Factor Fault Timeout
	Warn	Under Power Factor Warning Enable
	Warn Level	Under Power Factor Warning Threshold

Load Shed, Rapid Cycle Lock Outs, Communication Loss Settings

From the settings page, you can navigate to and edit the following voltage load shed, rapid cycle lockout, and communication loss settings:

Level 4	Level 5	Parameter name
Settings Addr.1-8		**–**
Load Shed	Fault	Load Shedding Enable
	Fault Level	Load Shedding Threshold
	Fault Time	Load Shedding Timeout
	RestartLvl	Load Shedding Restart Threshold
	RestartTimel	Load Shedding Restart Timeout
LockOuts	RpdCycle Time	Rapid Cycle Lockout Timeout
	Starts PerHr	Starts Per Hour Lockout Threshold
Comm Loss	NET PORT COMM LOSS	–
	Fault	Network Port Fault Enable
	Fault Time	Network Port Comm Loss Timeout
	HMI PORT COMM LOSS	–
	Fault	HMI Port Fault Enable

Statistics (1-to-many)

Overview

The Magelis® XBTN410 HMI provides read-only statistics pages–nested in levels 4 and 5 of the menu structure–for a selected LTM R controller.

To navigate to the statistics page, use one of the following paths:

Level	From this page...	Select...
1	Home page	Starters currents, or Starters status
2	Starters Currents page, or Starters Status page	LTM R controller number
3	Motor Starter page	Statistics

For information on navigating the 1-to-many menu structure, see *p. 398*.

Statistics

From the settings page, you can navigate to and read the following statistics:

Level 4	Level 5	Parameter name
Statistics Addr. 1-8		**–**
MaxTemp LTMR		–
OperTime		Voltage Phase Imbalance Fault Enable
AllStarts		Voltage Phase Imbalance Fault Threshold
LastStartDur		Voltage Phase Imbalance Fault Timeout Starting
LastStartAmp		Voltage Phase Imbalance Fault Timeout Running
All Faults		Voltage Phase Imbalance Warning Enable
Overload Flts		Voltage Phase Imbalance Warning Threshold
Overload Warn		–
Curr Imb Flts		Voltage Phase Loss Fault Enable
LongStart Flts		Voltage Phase Loss Fault Timeout
UnderCurr Flts		Voltage Phase Loss Warning Enable
Ground Faults		Voltage Phase Reversal Fault Enable
HMI Loss Flts		–
Ntwk Int Flts		Overvoltage Fault Enable
Ntwk Cnfg Flts		Overvoltage Fault Threshold
Ntwk Port Flts		Overvoltage Fault Timeout
Internal Flts		Overvoltage Warning Enable
InterPort Flts		Overvoltage Warning Threshold

Level 4	Level 5	Parameter name
Statistics Addr. 1-8		**–**
Fault n-0	Date	Date And Time n-0
	Time	Date And Time n-0
	FLC Ratio	Motor Full Load Current Ratio n-0
	FLC Max	Motor Full Load Current Max n-0
	Avg Current	Average Current n-0
	L1 Current	L1 Current Ratio n-0
	L2 Current	L2 Current Ratio n-0
	L3 Current	L3 Current Ratio n-0
	GRCurr	Ground Current Ratio n-0
	Curr Imbalance	Current Phase Imbalance n-0
	Th Capacity	Thermal Capacity Level n-0
	Avg Voltage	Average Voltage n-0
	L1-L2 Voltage	L1-L2 Voltage n-0
	L2-L3 Voltage	L2-L3 Voltage n-0
	L3-L1 Voltage	L3-L1 Voltage n-0
	Volt Imbalance	Voltage Phase Imbalance n-0
	Frequency	Frequency n-0
	Active Pwr	Active Power n-0
	Power Factor	Power Factor n-0
	Temp Sensor	Motor Temp Sensor n-0

Level 4	Level 5	Parameter name
Statistics Addr. 1-8		**–**
Fault n-1	Date	Date And Time n-1
	Time	Date And Time n-1
	FLC Ratio	Motor Full Load Current Ratio n-1
	FLC Max	Motor Full Load Current Max n-1
	Avg Current	Average Current n-1
	L1 Current	L1 Current Ratio n-1
	L2 Current	L2 Current Ratio n-1
	L3 Current	L3 Current Ratio n-1
	GRCurr	Ground Current Ratio n-1
	Curr Imbalance	Current Phase Imbalance n-1
	Th Capacity	Thermal Capacity Level n-1
	Avg Voltage	Average Voltage n-1
	L1-L2 Voltage	L1-L2 Voltage n-1
	L2-L3 Voltage	L2-L3 Voltage n-1
	L3-L1 Voltage	L3-L1 Voltage n-1
	Volt Imbalance	Voltage Phase Imbalance n-1
	Frequency	Frequency n-1
	Active Pwr	Active Power n-1
	Power Factor	Power Factor n-1
	Temp Sensor	Motor Temp Sensor n-1

Product ID (1-to-many)

Overview

The Magelis® XBTN410 HMI provides a description of the product number and firmware for both the LTM R controller and expansion module.

To navigate to the product ID page, use one of the following paths:

Level	From this page...	Select...
1	Home page	Starters currents, or Starters status
2	Starters Currents page, or Starters Status page	LTM R controller number
3	Motor Starter page	Product ID

For information on navigating the 1-to-many menu structure, see *p. 398*.

Product ID

In the Product ID page, you can read the following information about the LTM R controller and expansion module:

Level 4	Parameter name / description
Product ID Addr. 1-8	**–**
LTMR Catalog Ref	Controller Commercial Reference (product number)
LTMR Firmware	Controller Firmware Version
LTME Catalog Ref	Expansion Commercial Reference (product number)
LTME Firmware	Expansion Firmware Version

Monitoring (1-to-many)

Overview

Use the Magelis® XBTN410 HMI, in a 1-to-many configuration, to monitor:

- operating status and average current for multiple LTM R controllers, or
- current, voltage and power parameters for a selected LTM R controller.

Monitoring Multiple LTM R controllers

Navigate to the following pages to simultaneously monitor these dynamically changing values for all LTM R controllers:

Navigate to this page...	To simultaneously monitor every LTM R controller's...
Starters currents page	Average current ratio.
Starters status page	Operating status (On, Off, Fault).

For more information on both the starters currents page and the starters status page, see *p. 407*.

Monitoring a Single LTM R Controller

Navigate to the motor starter page for a selected LTM R controller to monitor the dynamically changing values of the following parameters:

- Current:
  - Average Current Ratio
  - L1 Current Ratio
  - L2 Current Ratio
  - L3 Current Ratio
  - Ground Current Ratio
  - Current Phase Imbalance
- Thermal
  - Thermal Capacity Level
  - Time To Trip
  - Motor Temp Sensor
- Voltage
  - Average Voltage
  - L1-L2 Voltage
  - L2-L3 Voltage
  - L3-L1 Voltage
  - Voltage Phase Imbalance
- Power
  - Power Factor
  - Active Power
  - Reactive Power

For more information on the motor starters page, see *p. 410*.

Fault Management (1-to-many)

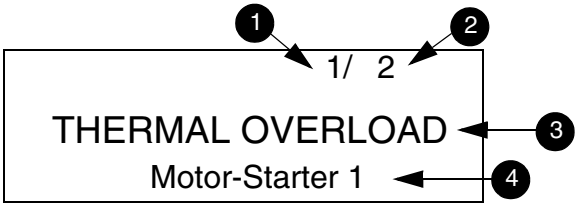
Overview

When a fault occurs, the Magelis® XBTN410 HMI automatically opens a fault display, consisting of 1 page for each active fault. Each page contains the:

- fault name
- address of the LTM R controller experiencing the fault
- total number of unresolved faults

Fault Display Pages

A typical fault display page looks like this:



1 fault display page number
2 total number of active faults
3 fault name (flashing)
4 address of LTM R controller experiencing the fault (flashing)

If more than 1 fault is active, use the ▶ and ◀ keypad buttons to move back and forth through the fault display pages.

Because some fault messages contain more than 4 lines of text, you may need to use the ▲ and ▼ keypad buttons to scroll up and down within a fault display page and display the entire fault message.

Opening/Closing the Fault Display

The 1-to-many HMI automatically opens the fault display whenever a fault occurs. When you remove the cause of a specific fault and execute a fault reset command, that fault no longer appears in the fault display.

You can also close the fault display by clicking the ESC keypad button. This does not fix the underlying cause of any fault, nor it does not clear any fault. You can re-open the fault display at any time by navigating to the Home page, scrolling to the Faults command line, then clicking the ▶ keypad button.

If you open the fault display when no faults are active, the HMI displays the message "No Faults Present".

For more information about navigating the menu structure, see *p. 398*.

Service Commands (1-to-many)

Overview

The Magelis® XBTN410, in 1-to-many configuration, provides the following service commands:

Command	Description	Location / reference
Self Test	Performs an internal check of the LTM R controller and expansion module.	Level 3, Motor Starter page (see *p. 411* and *p. 503*).
Reset to Defaults: Statistics	Executes the Clear Statistics Command for a selected LTM R controller.	Level 2, Reset to Defaults page (see *p. 409*).
Reset to Defaults: Settings	Executes the Clear Controller Settings Command for a selected LTM R controller.	Level 2, Reset to Defaults page (see *p. 409*).
Remote Reset	Performs remote fault reset for a selected LTM R controller	Level 2, Remote Reset page (see *p. 408*).

8.6 Using PowerSuite™ Software

At a Glance

Summary

The following topics show you how to use the LTM R controller when it is connected to a PC running PowerSuite™ software.

What's in this Section?

This section contains the following topics:

Topic	Page
Software Installation	427
User Interface	428
File Management	430
Navigation	434
Configuring Parameters	436
Configuration Functions Using PowerSuite™	438
Metering and Monitoring	439
Fault Management	442
Control Commands	444

Software Installation

Overview

PowerSuite™ software is a Microsoft® Windows®-based program that can be installed on any PC running the Microsoft® Windows 95, Windows 98, Windows NT® V4.0, or Windows XP® operating system. To install PowerSuite software, follow the instructions that come with your version of this software.

Your LTM R controller ships with its own configuration software application (LTM CONF). The LTM CONF configuration software is the same software incorporated within PowerSuite software version 2.5.

Software Installation

Follow these steps to install PowerSuite software on your PC:

Step	Action
1	Place the installation disk into your PC's CD/DVD drive.
2	Navigate to and click on the file Setup.exe. The setup wizard begins.
3	Follow the self-explanatory instructions in the set-up wizard.

Cable Connection

Use the RS-232 to RS-485 converter with PC and LTM R communication cable to connect the LTM R controller– or expansion module–to the PC.

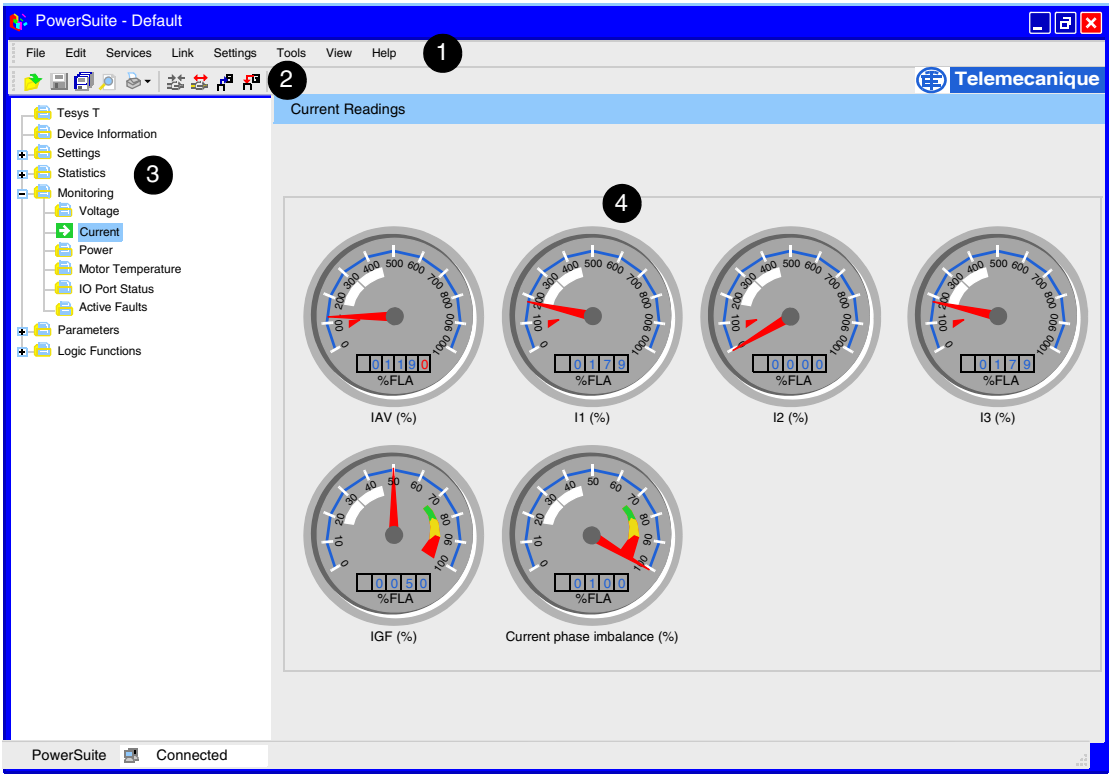
User Interface

Overview

PowerSuite™ software is a Microsoft® Windows®-based program that provides an intuitive graphical user interface for the LTM R controller. This software can be used:

- in standalone mode, to edit configuration files for the LTM R controller and save the edited files to your choice of media, including your PC's hard drive, or a CD.
- connected to the Local HMI port of the LTM R controller or expansion module, to:
  - upload configuration files from the LTM R controller to the PowerSuite software for editing
  - download edited configuration files from the PowerSuite software to the LTM R controller
  - monitor the operation of the LTM R controller, expansion module and equipment
  - maintain the LTM R controller
  - control the motor.

Example PowerSuite™ software presents the following user interface:



1 Menu bar
2 Icon bar
3 Tree control
4 Main window

Expand the tree control, then select an item to display configuration, monitoring and control data in the main window.

Use the menu bar and icon bar to perform configuration, monitoring and control functions.

For information on how to use each screen in the configuration software, refer to the Help menu's help file commands.

File Management

Overview

The LTM R controller's configuration settings are contained in an electronic configuration file. Use PowerSuite software to manage the LTM R controller's configuration files by:

- creating a new configuration file for editing
- transfer configuration settings from the LTM R controller to the configuration software running on your PC
- opening configuration settings for editing
- saving edited configuration settings to a file on your PC's hard disk, or to other media
- transferring saved or edited configuration files from your PC to the LTM R controller.

Power-up

Every time you open the configuration software, it presents the Load Configuration dialog. Use this dialog to select the configuration settings that will be displayed when the configuration software opens. You can select:

- the factory default configuration settings, or
- any previously saved configuration settings file.

Creating Files

The recommended way to create a configuration file is to transfer a configuration from the LTM R controller and save it. When you do this, all of the descriptive information about the LTM R controller and expansion module is automatically retrieved and copied to your PC.

When you create a new file using the File menu's **New Configuration** command, you must manually input this information, which is internally stored by the devices but may not otherwise be readily available.

Note: When you edit the network protocol for either a new configuration file, or for a configuration file transferred from the LTM R controller, the configuration software automatically changes network settings to their default values for the selected network protocol.

File Transfer - Device to PC

To transfer configuration settings from the LTM R controller to the PC and save those settings in a new configuration file:

Step	Action
1	Be sure the configuration software is communicating with the LTM R controller: If the task bar indicates "Disconnected", select **Connect** in either the icon bar or in the Link menu.
2	Transfer the configuration from the LTM R controller to your PC. Select **Device to PC** in either the icon bar or the Link to File → Transfer sub-menu.
3	After the configuration settings are transferred, use the configuration software to change configuration settings.
4	After your configuration setting edits are complete, save your work to a file: • Select the **Save** command in either the icon bar or the File menu. The Save As dialog opens. - then - • In the Save As dialog, navigate to the desired location and click **Save**.

Saving Files

Save a copy of any configuration file you intend to transfer to the LTM R controller. A saved copy provides both a record of these settings, and a backup that can be used to re-transfer configuration settings if the initial transfer fails.

Use the:

- **Save** command to save your configuration changes to the open configuration file
- **Save As** command to save a copy of the displayed configuration to a separate file.

Note: If you opened the file containing the factory default configuration settings, you cannot make and save changes to this file. Instead, you must use the **Save As** command to save your changes under another file name.

By default, the configuration software stores saved files in a folder named "Configurations". This folder is located on your hard drive in the same place the configuration software was installed.

To designate a different default file storage folder:

Step	Action
1	In the Settings menu, select **Preferences**. The Preferences dialog opens.
2	In the Preferences dialog, open the Configuration tab.
3	In the Configuration tab type in the folder name and path for saving configuration files.
4	Click **OK** to close the Preferences dialog and save your changes.

File Transfer - PC to Device

After you have edited a configuration file, you can transfer the file to the LTM R controller. Before the configuration software can make this transfer, the following conditions must exist:

- at least one setting in the configuration file must be different than the same setting in the LTM R controller - i.e., the software only overwrites settings with different values
- current must be less than 10% of FLC - i.e., online current must not be detected.

Note: When you transfer a configuration file from the PC to the LTM R controller, the software checks to confirm that the LTM R controller and the configuration file both use the same:

- current range, and
- network protocol

If there is a mismatch, the software asks if you wish to proceed. If you elect to proceed, the software transfers all matching parameters, excluding parameters that fail a range check. When the transfer is complete, the software displays the names and addresses of parameters that failed the range check and were not transferred.

To transfer a configuration file from the PC to the LTM R controller:

Step	Action
1	Be sure the configuration software is communicating with the LTM R controller: If the task bar indicates "Disconnected", select **Connect** in either the icon bar or in the Link menu.
2	Be sure the file to be transferred is in the Main window. To open a file: • select the **Open Configuration** command in either the icon bar or the File menu. The Open dialog opens. - then - • in the Open dialog, navigate to the desired location and click **Open**.
3	Transfer the configuration from your PC to the LTM R controller. Select **PC to Device** in either the icon bar or the Link to File → Transfer sub-menu.

Export Settings

The configuration software can also export a list of all configured parameters. This list can be exported in the following electronic file formats:

- spreadsheet (.csv)
- HTML
- text
- XML

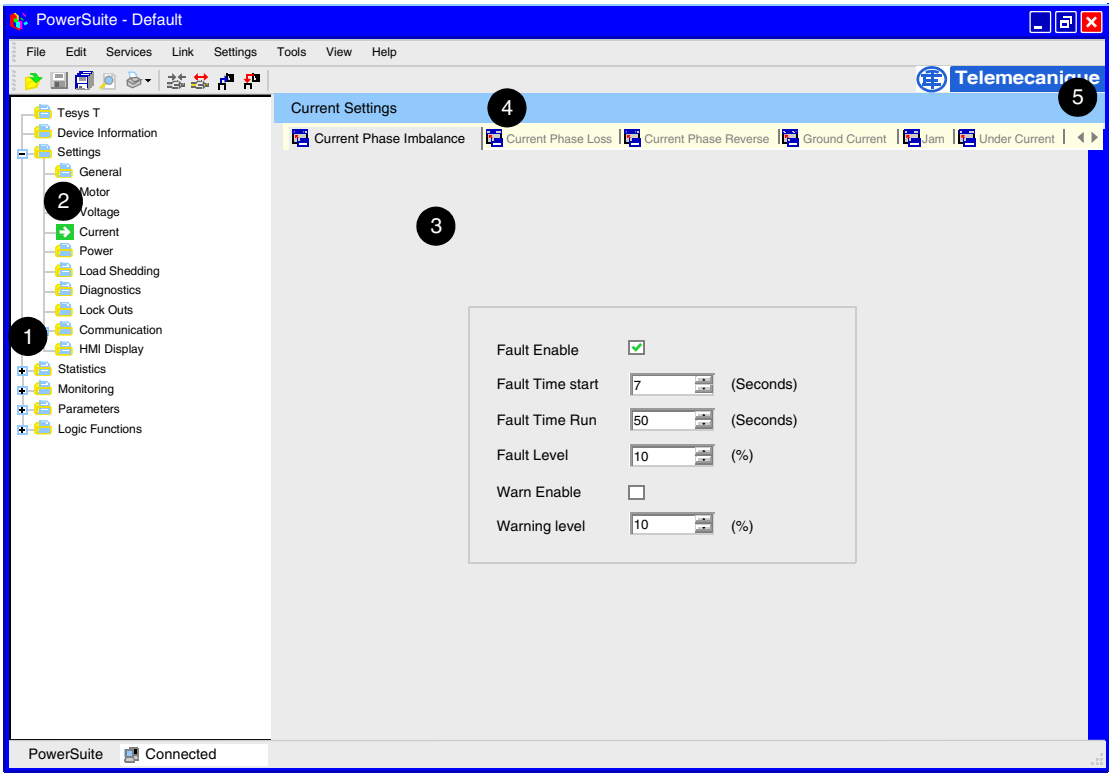
The exported list indicates each parameter's:

- read or write status
- memory address
- name
- unit of measure
- value as edited in the configuration software (local value)
- default value
- value as stored in the LTM R controller (device value)
- minimum value
- maximum value
- status

Navigation

Overview

To navigate the configuration software interface, use the features of the tree control and main window, identified below:



1 Expand (+) or contract (-) branch on tree control
2 Green shaded arrow indicates the selected tree control branch
3 Main window displays the contents of the selected tree control branch
4 Tabs indicate this main window selection includes multiple pages. Click on a tab to display its contents.
5 Left and right arrows indicate additional tabbed pages. Click on these arrows to display additional pages.

Steps

Navigating the configuration software interface is a simple, 2-step process:

Step	Description
1	In the tree control on the left side of the interface, navigate to an end branch: • (if necessary) click on a + node to open that branch - then - • select the branch you want. The selected branch is marked by a green-shaded arrow. The main window displays information related to the selected branch.
2	In the main window on the right side of the interface: • (if necessary) for some multi-tabbed pages, click on the < or > arrow to navigate through the page tabs, then select a tab - or - • (if necessary) use the scroll bars at the top or bottom of the page to view the desired information

Configuring Parameters

Overview

Use PowerSuite software to configure parameter settings remotely in your PC, then transfer the edited parameter settings to the LTM R controller. The configuration software uses the edited parameter settings to overwrite the parameter settings in the LTM R controller only when the following conditions are met:

- at least one transferred parameter setting is different from the same setting in the LTM R controller, and
- measured current is less than 10% of FLC.

Configurable parameters can be found in the:

- Settings branch of the tree control
- Settings menu's Languages sub-menu
- Communication page of the Preferences dialog.

After you have completed making your edits, be sure to save your work. See *p. 431* for information on saving files.

Note: You can also use the Custom Logic Editor to edit parameter settings, before transferring them to the LTM R controller.

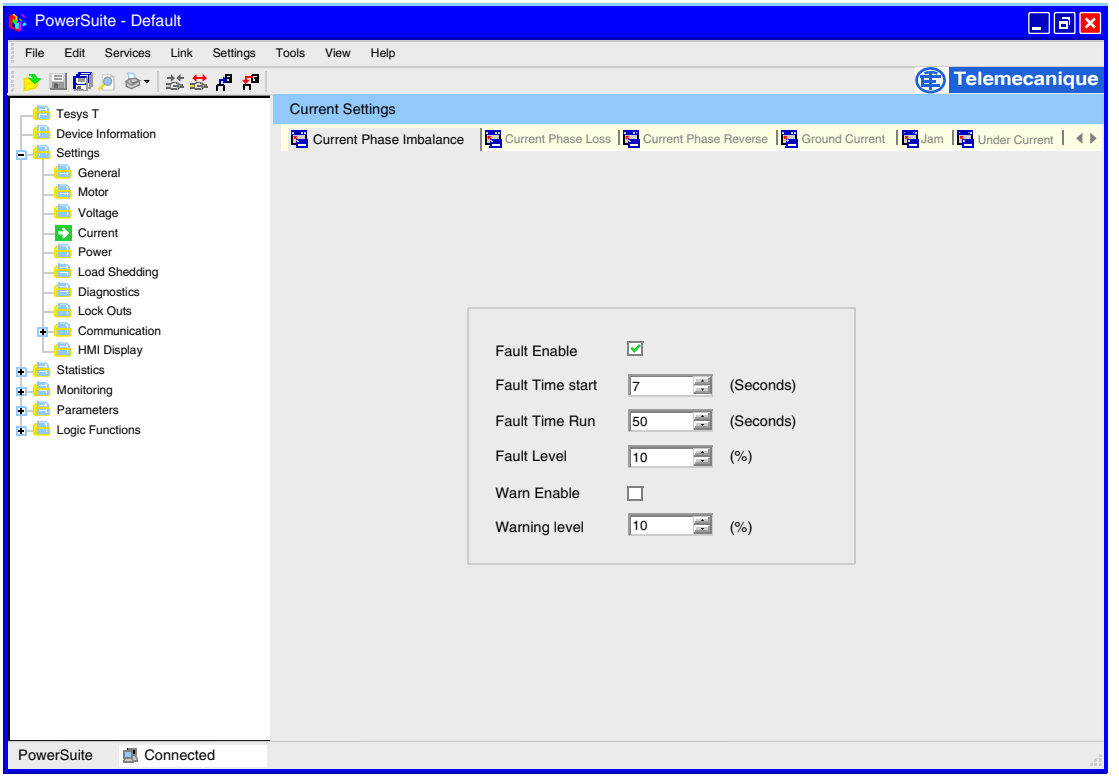
Selecting a File

To configure parameters, first select a configuration file to edits. Either:

- transfer parameter settings from the LTM R controller to the configuration software in your PC using the **Device to PC** command in the Link → File Transfer sub-menu. See *p. 431* for information on uploading parameter settings.
- open a previously saved configuration file.

Settings Branch

After opening a configuration file, expand the tree control Settings branch and select each sub-branch. The main window displays the configurable parameters associated with the selected sub-branch.



You can select Settings sub-branches in any order.

Make your edits in the main window.

Languages Sub-menu

You can select an HMI display language in the Settings → Languages sub-menu. You can also make this selection by navigating to the Settings → General sub-branch of the tree control.

Preferences Dialog

The Communications page of the Preferences dialog also contains configurable parameter settings. To access these settings, select **Preferences** in the Settings menu.

Configuration Functions Using PowerSuite™

Overview

The configuration software's Services menu provides access to the following configuration functions:

- Reset to Factory (Restore Factory Defaults)
- Password

Restore Factory Defaults

Use the Services → **Reset to Factory** command to clear all settings and restore factory defaults. This menu command executes the Clear All Command parameter.

For a list of general parameters and their factory default settings, see *p. 45*; for a list of protection parameters and their factory default settings, see *p. 119*.

Password

Use the Services → **Password** command to access a dialog where you can enable password protection and create a password. Using a password helps prevent unauthorized configuration of controller parameters. Password protection is disabled by default.

Your password must be an integer between 0000 and 9999. The controller saves the password in the HMI Keypad Password parameter.

Metering and Monitoring

Overview

Use the PowerSuite software to monitor dynamically changing parameter values. To locate dynamically changing parameter values, use the tree control to navigate to and select sub-branches of either of the following main branches:

- Monitoring
- Parameters.

Before you can monitor parameter values, an active communications link must be established between the configuration software and the LTM R controller.

The configuration software periodically updates parameter values accessed through the Monitoring and Parameters branches. The refresh rates for updating Monitoring branch and Parameters branch values are separately editable.

Communications Link

To monitor dynamically changing parameters, a communications link must be active between the configuration software in your PC and the LTM R controller. To find out if a link exists, check the taskbar at the bottom of the configuration software. If the taskbar indicates:

- *Connected*, a communications link between the PC and LTM R controller exists and you can monitor dynamically changing parameter values.
- *Disconnected*, select **Connect** in either the icon bar or the Link menu.

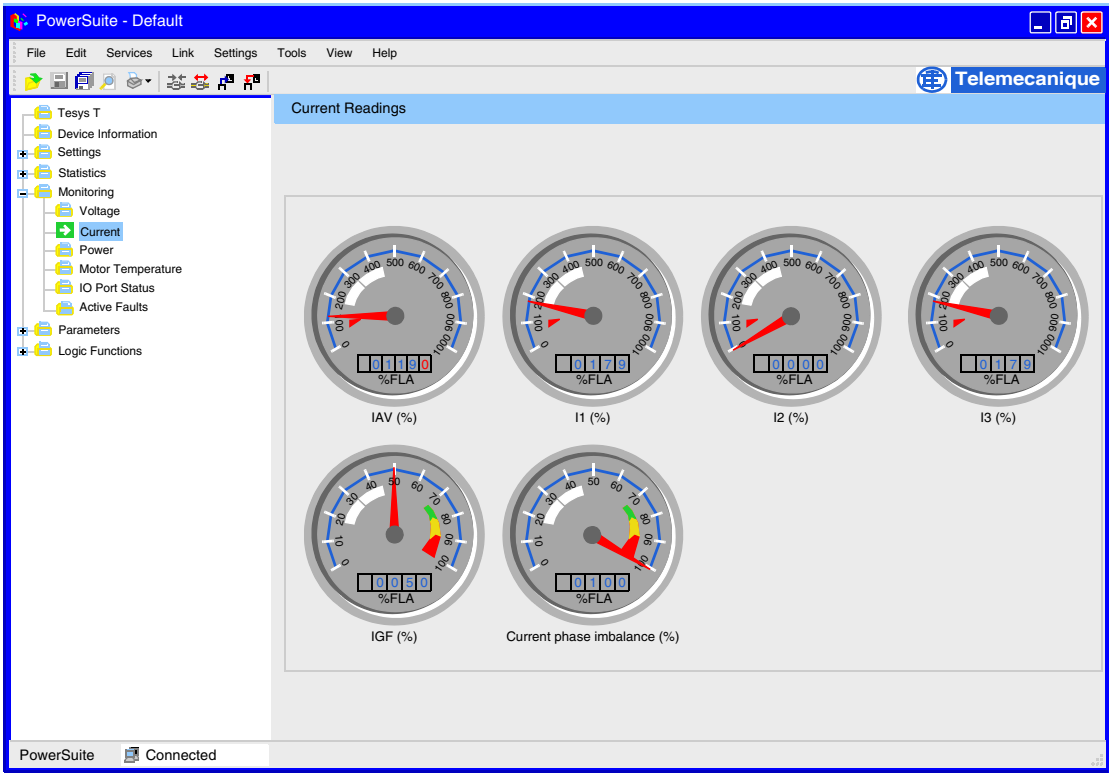
Refresh Rates

Use the Monitoring page of the Preferences dialog to set the rates the LTM R controller uses to update monitored parameter values:

Step	Action
1	In the Settings menu, select **Preferences**. The Preferences dialog opens.
2	In the Preferences dialog, select the **Monitoring** tab.
3	In the Monitoring page: • Set the Readings Refresh Rate, in seconds, for parameter values displayed in the Monitoring branch • Set the Parameters Refresh Rate, in seconds, for parameter values displayed in the Parameters branch.
4	Click **OK** to save your settings.

Monitoring Branch

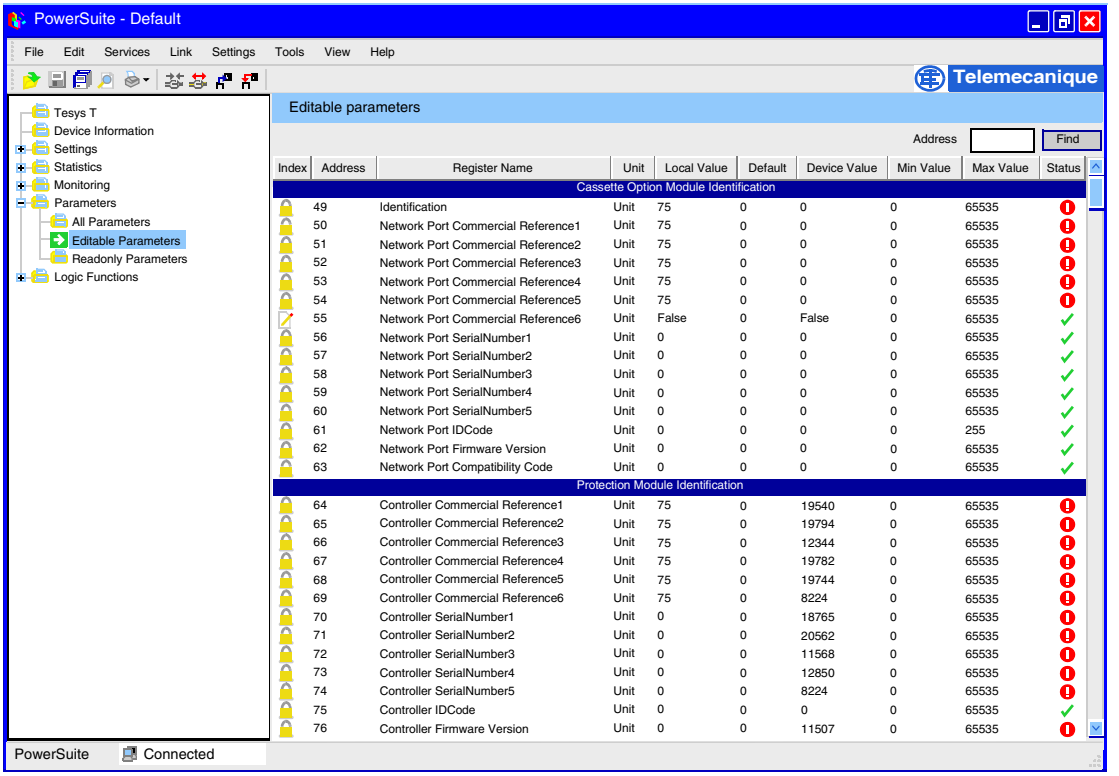
Select a Monitoring sub-branch to display a series of graphical gauges (shown below) or fault and warning LEDs that provide an easy-to-read status update of the monitored parameters.



See *p. 434* for information about navigating the user interface.

Parameters Branch

Select a Parameters sub-branch to display information about all, editable, or read-only parameters. The Device Value column indicates the most recently reported value of the monitored parameter.


PowerSuite - Default
File
Edit
Services
Link
Settings
Tools
View
Help
Telemecanique
Tesys T
Device Information
Settings
Statistics
Monitoring
Parameters
All Parameters
Editable Parameters
Readonly Parameters
Logic Functions
Editable parameters
Address
Find
Index
Address
Register Name
Unit
Local Value
Default
Device Value
Min Value
Max Value
Status
Cassette Option Module Identification
49 Identification Unit 75 0 0 0 65535
50 Network Port Commercial Reference1 Unit 75 0 0 0 65535
51 Network Port Commercial Reference2 Unit 75 0 0 0 65535
52 Network Port Commercial Reference3 Unit 75 0 0 0 65535
53 Network Port Commercial Reference4 Unit 75 0 0 0 65535
54 Network Port Commercial Reference5 Unit 75 0 0 0 65535
55 Network Port Commercial Reference6 Unit False 0 False 0 65535
56 Network Port SerialNumber1 Unit 0 0 0 0 65535
57 Network Port SerialNumber2 Unit 0 0 0 0 65535
58 Network Port SerialNumber3 Unit 0 0 0 0 65535
59 Network Port SerialNumber4 Unit 0 0 0 0 65535
60 Network Port SerialNumber5 Unit 0 0 0 0 65535
61 Network Port IDCode Unit 0 0 0 0 255
62 Network Port Firmware Version Unit 0 0 0 0 65535
63 Network Port Compatibility Code Unit 0 0 0 0 65535
Protection Module Identification
64 Controller Commercial Reference1 Unit 75 0 19540 0 65535
65 Controller Commercial Reference2 Unit 75 0 19794 0 65535
66 Controller Commercial Reference3 Unit 75 0 12344 0 65535
67 Controller Commercial Reference4 Unit 75 0 19782 0 65535
68 Controller Commercial Reference5 Unit 75 0 19744 0 65535
69 Controller Commercial Reference6 Unit 75 0 8224 0 65535
70 Controller SerialNumber1 Unit 0 0 18765 0 65535
71 Controller SerialNumber2 Unit 0 0 20562 0 65535
72 Controller SerialNumber3 Unit 0 0 11568 0 65535
73 Controller SerialNumber4 Unit 0 0 12850 0 65535
74 Controller SerialNumber5 Unit 0 0 8224 0 65535
75 Controller IDCode Unit 0 0 0 0 65535
76 Controller Firmware Version Unit 0 0 11507 0 65535
PowerSuite
Connected

QuickWatch Window

Instead of monitoring large groupings of parameters, you can elect to monitor only a short list of parameters that you select. To do this:

Step	Description
1	In the View menu, select **QuickWatch Window**. The QuickWatch Window opens.
2	In the QuickWatch Window, type in a parameter address and click the **Add Watch** button. The parameter is added to the list. **Note:** You can find a parameter address by selecting All Parameters in the Parameters branch, then looking for the parameter name and address.
3	Repeat step 2 for every parameter you wish to add to the list.

The QuickWatch Window parameter list is updated with the same frequency as the screens in the Parameters branch.

Fault Management

Overview

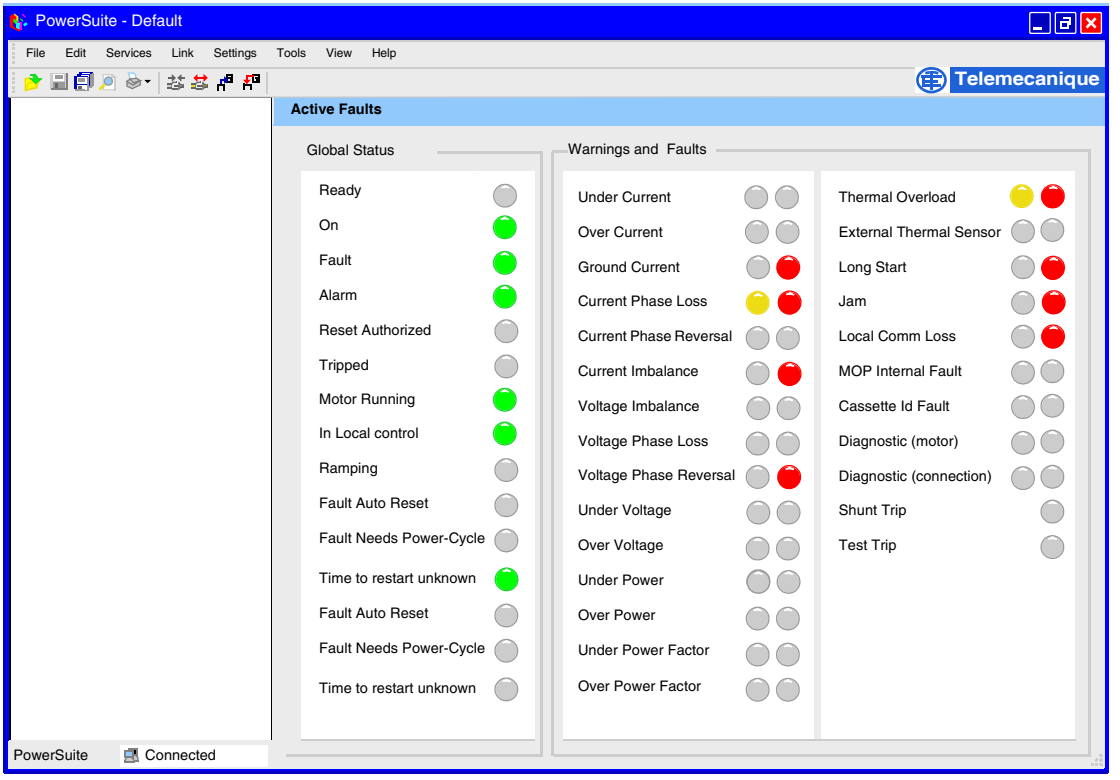
Use PowerSuite™ software to monitor the status of all enabled fault parameters.

Fault Monitoring

In the tree control, navigate to and select Monitoring → Active Faults to display a graphical display of fault LEDs (see below). The LTM R controller monitors its global status, and detects warnings and faults. PowerSuite software displays this information using color-coded LEDs:

Information type	LED color	Description
Global status	Solid gray	Condition not detected
	Solid green	Condition detected
Warnings and Faults	Solid gray	No warning or fault, or protection not enabled
	Solid yellow	Warning
	Solid red	Fault

The fault monitoring screen in PowerSuite software looks like this:



Control Commands

Overview

PowerSuite™ software provides the following control commands:

- Self Test
- Clear:
  - Protection Settings
  - Network Port Settings
  - Statistics
  - Thermal Capacity Level

These commands take effect immediately upon execution. They are available only when the configuration software is communicating with the LTM R controller.

Self Test

Use the self test command to check the internal workings of both the LTM R controller and the expansion module. The self test command is located in the Services menu under Services → Maintenance → Self Test.

For more information on the self-test function, see *p. 503*.

Clear

Use the clear commands for the purposes described below:

Command	Description	Parameter name
Protection Settings	Restores all protection parameters to their factory default settings.	Clear Controller Settings Command
Network Port Settings	Restores network port parameters to their factory default settings.	Clear Network Port Settings Command
Statistics	Sets all historical statistics to 0.	Clear Statistics Command
Thermal Capacity Level	Sets to 0 the Thermal Capacity Level and Rapid Cycle Lockout Timeout parameters. See the warning below.	Clear Thermal Capacity Level Command

⚠ WARNING

LOSS OF MOTOR PROTECTION

Clearing the thermal capacity level inhibits thermal protection and can cause equipment overheating and fire. Continued operation with inhibited thermal protection should be limited to applications where immediate restart is vital.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

8.7 Using the Modbus® Communication Network

Introduction to the Modbus® Communication Network

Overview

This section describes how to use the controller via the network port using Modbus.

What's in this Section?

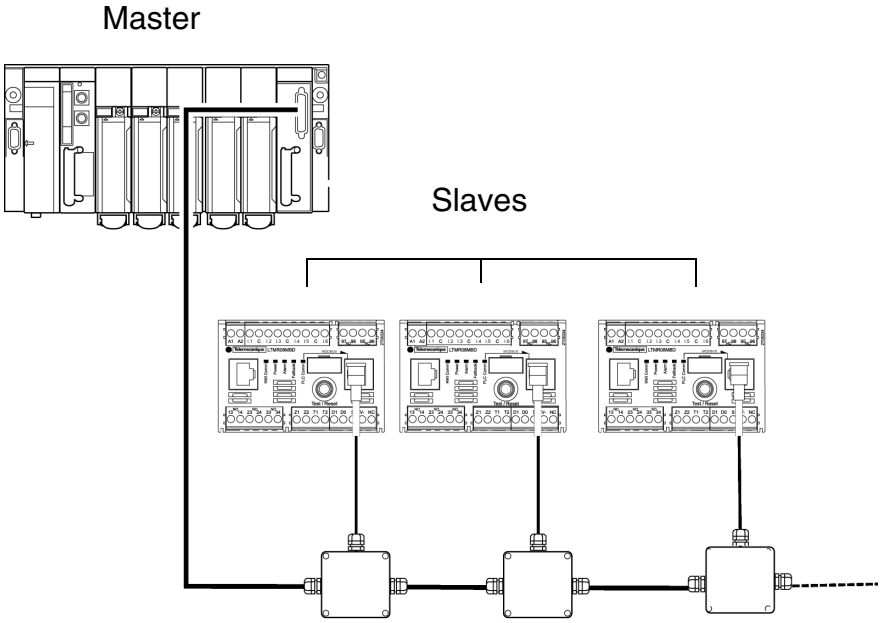
This section contains the following topics:

Topic	Page
Modbus® Protocol Principle	446
Configuration of the LTM R Modbus® Network Port	447
Communication Parameter Clear Commands	448
Simplified Control and Monitoring	450
Modbus® Request and Programming Examples	451
User Map (User Defined Indirect Registers)	453
Modbus Register Map - Organization of Communication Variables	454
Data Formats	456
Data Types	458
Identification Variables	465
Statistics Variables	466
Monitoring Variables	476
Configuration Variables	483
Command Variables	493
User Map Variables	494
Custom Logic Variables	495

Modbus® Protocol Principle

Overview

The Modbus protocol is a master-slave protocol:



Only 1 device can transmit on the line at any time.

The master manages and initiates the exchange. It interrogates each of the slaves in succession. No slave can send a message unless it is invited to do so.

The master repeats the question when there is an incorrect exchange, and declares the interrogated slave absent if no response is received within a given time period.

If a slave does not understand a message, it sends an exception response to the master. The master may or may not retransmit the request.

Modbus Dialogue

2 types of dialogue are possible between master and slaves:

- The master sends a request to a slave and waits for its response.
- The master broadcasts a request to all slaves without waiting for a response.

Direct slave-to-slave communications are not possible. For slave-to-slave communication, the master must therefore interrogate a slave and send back data received to the other slave.

Configuration of the LTM R Modbus® Network Port

Communication Parameters

Before any communication can start, use PowerSuite™ or the HMI to configure the Modbus communication parameters:

- Network port address setting
- Network port baud rate setting
- Network port parity setting
- Network port comm loss timeout

Network Port Address Setting

The device address can be set between 1 and 247.

Default value is "65,535", which corresponds to an undefined value.

Network Port Baud Rate Setting

Possible transmission rates are:

- 1,200 bps
- 2,400 bps
- 4,800 bps
- 9,600 bps
- 19,200 bps
- Autobaud

Default value is Autobaud. In Autobaud, the controller is able to adapt its baud rate to the one of the master. 19,200 bps is the first baud rate to be tested.

Network Port Parity Setting

The parity can be selected from:

- Even
- Odd
- None
- Autodetection

Default value is Autodetection. In Autodetection, the controller is able to adapt its parity and stop bit to that of the master. Even parity is the first parity to be tested.

Parity and stop bit behavior is linked:

If the parity is...	Then the number of stop bits is...
Even or odd	1
None	2

Network Port Comm Loss Timeout

Network port comm loss timeout is used to determine the timeout value after a loss of communication with the PLC.

- Range: 1-9,999

Network Port Fallback Setting

Network port fallback setting is used to adjust the fallback mode in case of a loss of communication with the PLC.

Communication Parameter Clear Commands

Clear Commands Overview

Communication parameters can be cleared using the following commands:

- Clear All Command (705.0)
- Clear Statistics Command (705.1)
- Clear Thermal Capacity Level Command (705.2)
- Clear Controller Settings Command (705.3)
- Clear Network Port Settings Command (705.4)

These parameters are read/write but only when the motor is off (except for the Clear Thermal Capacity level command, see below).

Clear All Command (705.0)

If you are using a new product with the controller, you may want to clear all existing parameters in order to set new parameters for the product.

To clear all parameters, set register 705.0 to 1.

This forces the system to enter configuration mode. A power-cycle is performed to restart correctly in this mode. This enables the system to pick up the new values for the cleared parameters.

Note: When you clear all parameters, static characteristics are also lost.

Only the following parameters are not cleared after a clear all command:

- Motor LO1 starts count
- Motor LO2 starts count
- Controller internal temperature max
- Thermal capacity level

Clear Statistics Command (705.1)

To clear statistics parameters, set register 705.1 to 1.

Statistics parameters are cleared without the system being forced into configuration mode. Static characteristics are preserved.

The following parameters are not cleared after a clear statistics command:

- Motor LO1 starts count
- Motor LO2 starts count
- Controller internal temperature max

Clear Thermal Capacity Level Command (705.2)

To clear thermal memory parameters, set register 705.2 to 1.

This action clears the following parameters:

- Thermal capacity level
- Thermal overload fault reset timeout
- Rapid cycle lockout timeout

Thermal memory parameters are cleared without the system being forced into configuration mode. Static characteristics are preserved.

Note: This bit is writeable at any time, even when the motor is turning.

For more information about the Clear Thermal capacity level command, see *p. 132*.

Clear Controller Settings Command (705.3)

The Clear controller settings command restores the controller protection default values (timeouts and thresholds).

To clear controller settings parameters, set register 705.3 to 1.

The following settings are *not* cleared by this command:

- Controller characteristics
- Connections (CT, temperature sensor, and I/O settings)
- Operating mode
- Custom logic

Controller setting parameters are cleared without the system being forced into configuration mode. Static characteristics are preserved.

Clear Network Port Settings Command (705.4)

The Clear network port settings command restores the controller's network setting default values (port address, baud rate, and parity).

To clear controller settings parameters, set register 705.4 to 1.

After executing this command, the network connection is closed.

To re-start the connection, you must enter a value for the network port address. (Other port settings can be used with their default values.)

Controller setting parameters are cleared without the system being forced into configuration mode. Static characteristics are preserved. Only the network communication becomes ineffective.

Note: For more information about clear commands, see *p. 382*.

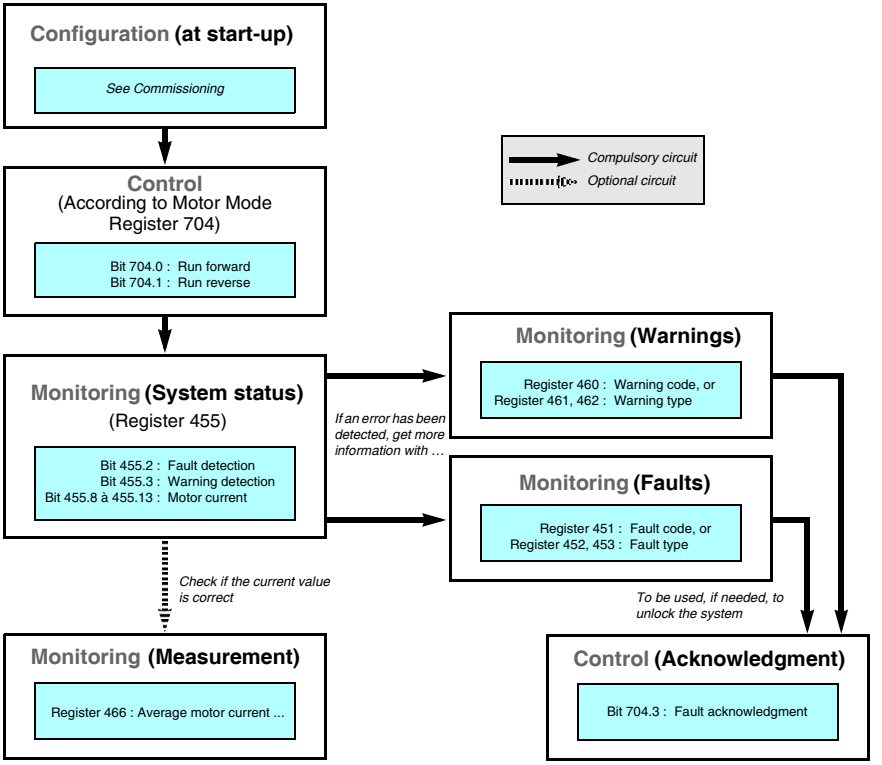
Simplified Control and Monitoring

Overview

This is a simplified example of the main registers which control and monitor a Motor Management Controller.

Registers for Simplified Operation

The illustration below provides basic setup information, using the following registers: configuration, control and monitoring (system status, measurements, faults and warnings, acknowledgement).


Configuration (at start-up)
See Commissioning
Compulsory circuit
Optional circuit
Control
(According to Motor Mode Register 704)
Bit 704.0 : Run forward
Bit 704.1 : Run reverse
Monitoring (System status)
(Register 455)
Bit 455.2 : Fault detection
Bit 455.3 : Warning detection
Bit 455.8 à 455.13 : Motor current
If an error has been detected, get more information with …
Monitoring (Warnings)
Register 460 : Warning code, or
Register 461, 462 : Warning type
Monitoring (Faults)
Register 451 : Fault code, or
Register 452, 453 : Fault type
Check if the current value is correct
To be used, if needed, to unlock the system
Monitoring (Measurement)
Register 466 : Average motor current ...
Control (Acknowledgment)
Bit 704.3 : Fault acknowledgment

Modbus® Request and Programming Examples

Modbus Request The following table indicates which Modbus functions are managed by the LTM R controller, and specifies their limits:

Code value		Function name	Broadcasting	Modbus standard name
Hexadecimal	Decimal			
0x03	3	Read N output words (multiple registers)	No	Read Holding Register
0x06	6	Write 1 output word (single register)	Yes	Preset Single Register
0x10	16	Write N output words (multiple registers)	Yes	Preset Multiple Regs
0x2B	43	Read identification (identification register)	No	Read Device Identification

The maximum number of registers per request is limited to 100.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

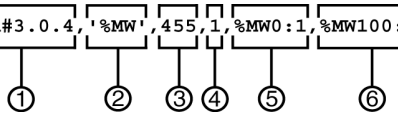
Use of this device on a Modbus network that uses the broadcast function should be considered with caution.
This device has a large number of registers that must not be modified during normal operation. Unintended writing of these registers by the broadcast function may cause unexpected and unwanted product operation.
For more information, refer to the Communication variables list.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

Example of a Read Operation (Modbus Request Code 3)

The example below describes a READ_VAR request, within a TSX Micro or Premium platform, in order to read the LTM R states at address 4 (slave n° 4) contained in internal word MW0:

```
If %M0 AND NOT %MW100:X0 THEN READ_VAR(ADR#3.0.4,'%MW',455,1,%MW0:1,%MW100:4) :RESET %M0;
EN_IF;
```

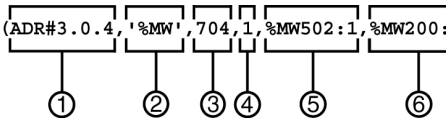


1 Address of the device with which you wish to communicate: 3 (device address), 0 (channel), 4 (device address on the bus)
2 Type of PL7 objects to be read: MW (internal word)
3 Address of the first register to be read: 455
4 Number of consecutive registers to be read: 1
5 Word table containing the value of the objects read: MW0:1
6 Read report: MW100:4

Example of a Write Operation (Modbus Request Code 16)

The example below describes a WRITE_VAR request, within a TSX Micro or Premium platform, in order to control an LTM R by sending the contents of internal word MW 502:

```
If %M0 AND NOT %MW200:X0 THEN WRITE_VAR(ADR#3.0.4,'%MW',704,1,%MW502:1,%MW200:4) :RESET %M10;
EN_IF;
```



1 Address of the device with which you wish to communicate: 3 (device address), 0 (channel), 4 (device address on the bus)
2 Type of PL7 objects to be written: MW (internal word)
3 Address of the first register to be written: 704
4 Number of consecutive registers to be written: 1
5 Word table containing the value of the objects to be sent: MW502:1
6 Write report: MW200:4

User Map (User Defined Indirect Registers)

User Map Overview

User Map is based on an indirect addressing system. It is designed to improve communication performance and flexibility.

User Map Details

User Map allows you to read values of non-contiguous registers in a continuous way.

Information is organized into 2 tables containing addresses and values.

The first table stores the addresses of registers to be read or written. By default, all addresses are null, which means that the addresses have not been assigned.

The second table is the read and write access point to assigned register values.

Modbus Register Map - Organization of Communication Variables

Introduction

Communication variables are listed in tables, according to the group (such as identification, statistics, or monitoring) to which they belong. They are associated with an LTM R controller, which may or may not have an LTM E Expansion Module attached.

Communication Variable Groups

Communication variables are grouped according to the following criteria:

Variable groups	Registers
Identification variables	00 to 99
Statistics variables	100 to 449
Monitoring variables	450 to 539
Configuration variables	540 to 699
Command variables	700 to 799
User Map variables	800 to 999
Custom Logic variables	1200 to 1399

Table Structure

Communication variables are listed in 4-column tables:

Column 1	Column 2	Column 3	Column 4
Register (in decimal format)	Variable type (see *p. 456*)	Variable name and access via Read-only or Read/Write Modbus requests	Note: code for additional information

Note

The Note column gives a code for additional information.

Variables without a code are available for all hardware configurations, and without functional restrictions.

The code can be:
- numerical (1 to 9), for specific hardware combinations
- alphabetical (A to Z), for specific system behaviors.

If the note is...	Then the variable is available for...
1	the LTM R + LTM EV40 combination
2 - 9	future combinations

If the note is...	Then...
A	the variable can be written only when the motor is off
B	the variable can be written only in configuration mode
C	the variable can be written only with no fault
D - Z	the variable is available for future exceptions

Unused Addresses

Unused addresses fall into 3 categories:
- **Not significant**, in Read-only tables, means that you should ignore the value read, whether equal to 0 or not.
- **Reserved**, in Read/Write tables, means that you must write 0 in these variables.
- **Forbidden**, means that read or write requests are rejected, that these addresses are not accessible at all.

Data Formats

Overview

The data format of a communication variable can be integer, Word, or Word[n], as described below. For more information about a variable size and format, see *p. 458*.

Integer (Int, UInt, DInt, IDInt)

Integers fall into the following categories:

- **Int**: signed integer using one register (16 bits)
- **UInt**: unsigned integer using one register (16 bits)
- **DInt**: signed double integer using two registers (32 bits)
- **UDInt**: unsigned double integer using two registers (32 bits)

For all integer-type variables, the variable name is completed with its unit or format, if necessary.

Example:

Address 474, **UInt**, Frequency (x 0.01 Hz).

Word

Word: Set of 16 bits, where each bit or group of bits represents command, monitoring or configuration data.

Example:

Address 455, **Word**, System Status Register 1

bit 0	System ready
bit 1	System on
bit 2	System fault
bit 3	System warning
bit 4	System tripped
bit 5	Fault reset authorized
bit 6	*(Not significant)*
bit 7	Motor running
bits 8-13	Motor average current ratio
bit 14	Control via HMI
bit 15	Motor starting (in progress)

Word[n]

Word[n]: Data encoded on contiguous registers.

Examples:

Addresses 64 to 69, **Word[6]**, Controller Commercial Reference (see *DT_CommercialReference*)

Addresses 655 to 658, **Word[4]**, Date and Time setting (see *DT_DateTime*).

Data Types

Overview

Data types are specific variable formats which are used to complement the description of internal formats (for instance, in case of a structure or of an enumeration). The generic format of data types is DT_xxx.

List of Data Types

Here is the list of the most commonly used DT_xxx formats:

DT_xxx names
DT_CommercialReference
DT_DateTime
DT_ExtOperatingMode
DT_FaultCode
DT_FirmwareVersion
DT_Language5
DT_WarningCode

Note: The DT_xxx formats are described below.

DT_Commercial Reference

DT_CommercialReference format is **Word[6]** and indicates a Commercial Reference:

Register	MSB	LSB
Register N	character 1	character 2
Register N+1	character 3	character 4
Register N+2	character 5	character 6
Register N+3	character 7	character 8
Register N+4	character 9	character 10
Register N+5	character 11	character 12

Example:

Addresses 64 to 69, **Word[6]**, Controller Commercial Reference.

If Controller Commercial Reference = LTM R:

Register	MSB	LSB
64	L	T
65	M	(space)
66	R	
67		
68		
69		

DT_DateTime

DT_DateTime format is **Word[4]** and indicates Date and Time:

Register	15 12	11 8	7 4	3 0
Register N	Y	Y	Y	Y
Register N+1	M	M	D	D
Register N+2	H	H	m	m
Register N+3	S	S	0	0

Where:

- Y = year
  The format is 4 Binary Coded Decimal (BCD) digits.
  The value range is [2006-2099].
- M = month
  The format is 2 BCD digits.
  The value range is [01-12].
- D = day
  The format is 2 BCD digits.
  The value range is:
  [01-31] for months 01, 03, 05, 07, 08, 10, 12
  [01-30] for months 04, 06, 09, 11
  [01-29] for month 02 in a leap year
  [01-28] for month 02 in a non-leap year.
- H = hour
  The format is 2 BCD digits.
  The value range is [00-23].
- m = minute
  The format is 2 BCD digits.
  The value range is [00-59].
- S = second
  The format is 2 BCD digits.
  The value range is [00-59].
- 0 = unused

Data entry format and value range are:

Data entry format	DT#YYYY-MM-DD-HH:mm:ss	
Minimum value	DT#2006-01-01:00:00:00	January 1, 2006
Maximum value	DT#2099-12-31-23:59:59	December 31, 2099
Note: If you give values outside the limits, the system will return an error.		

Example:

Addresses 655 to 658, **Word[4]**, Date and Time setting.

If date is September 4, 2008 at 7 a.m., 50 minutes and 32 seconds:

Register	15 12	11 8	7 4	3 0
655	2	0	0	8
656	0	9	0	4
657	0	7	5	0
658	3	2	0	0

With data entry format: DT#2008-09-04-07:50:32.

DT_ExtOperating Mode

DT_ExtOperatingMode format is an **enumeration** of motor operating modes:

Value	Description
2	2-wire overload
3	3-wire overload
4	2-wire independent
5	3-wire independent
6	2-wire reverser
7	3-wire reverser
8	2-wire 2-step
9	3-wire 2-step
10	2-wire 2-speed
11	3-wire 2-speed
258	Custom 2-wire overload
259	Custom 3-wire overload
260	Custom 2-wire independent
261	Custom 3-wire independent
262	Custom 2-wire reverser
263	Custom 3-wire reverser
264	Custom 2-wire 2-step
265	Custom 3-wire 2-step
266	Custom 2-wire 2-speed
267	Custom 3-wire 2-speed

DT_FaultCode

DT_FaultCode format is an **enumeration** of fault codes:

Fault code	Description
0	No error
3	Ground current
4	Thermal overload
5	Long start
6	Jam
7	Current phase imbalance
8	Undercurrent
10	Test
11	HMI port error
12	HMI port communication loss
13	Network port internal error
18	Diagnostic
19	Wiring
20	Overcurrent
21	Current phase loss
22	Current phase reversal
23	Motor temp sensor
24	Voltage phase imbalance
25	Voltage phase loss
26	Voltage phase reversal
27	Undervoltage
28	Overvoltage
29	Underpower
30	Overpower
31	Under power factor
32	Over power factor
33	Load shedding
51	Controller internal temperature error
55	Controller internal error (Stack overflow)
56	Controller internal error (RAM error)
57	Controller internal error (RAM checksum error)
58	Controller internal error (Hardware watchdog fault)
59	Controller internal error

Fault code	Description
60	L2 current detected in 1-phase mode
64	EEPROM error
65	Expansion module communication error
66	Stuck reset button
67	Logic function error
100-104	Network port internal error
109	Network port comm error
555	Network port configuration error

DT_Firmware Version

DT_FirmwareVersion format is an **XY000 array** that describes a firmware revision:

- X = major revision
- Y = minor revision.

Example:

Address 76, **UInt**, Controller firmware version.

DT_Language5

DT_Language5 format is a **bit string** used for language display:

Language code	Description
1	English (default)
2	Français
4	Español
8	Deutsch
16	Italiano

Example:

Address 650, **Word**, HMI language.

DT_WarningCode **DT_WarningCode** format is an **enumeration** of warning codes:

Warning code	Description
0	No warning
3	Ground current
4	Thermal overload
5	Long start
6	Jam
7	Current phase imbalance
8	Undercurrent
10	Test
11	HMI port error
12	HMI port communication loss
13	Network port internal error
18	Diagnostic
19	Wiring
20	Overcurrent
21	Current phase loss
22	Current phase reversal
23	Motor temp sensor
24	Voltage phase imbalance
25	Voltage phase loss
26	Voltage phase reversal
27	Undervoltage
28	Overvoltage
29	Underpower
30	Overpower
31	Under power factor
32	Over power factor

Identification Variables

Identification Variables

Identification variables are described below:

Register	Variable type	Read-only variables	*Note, p. 455*
0-34		*(Not significant)*	
35-40	Word[6]	Expansion commercial reference (See *DT_CommercialReference, p. 459*)	1
41-45	Word[5]	Expansion serial number	1
46	UInt	Expansion ID code	1
47	UInt	Expansion firmware version (See *DT_Firmware Version, p. 463*)	1
48	UInt	Expansion compatibility code	1
49-60		*(Not significant)*	
61	UInt	Network port ID code	
62	UInt	Network port firmware version (See *DT_Firmware Version, p. 463*)	
63	UInt	Network port compatibility code	
64-69	Word[6]	Controller commercial reference (See *DT_CommercialReference, p. 459*)	
70-74	Word[5]	Controller serial number	
75	Word	Controller ID code	
76	UInt	Controller firmware version (See *DT_Firmware Version, p. 463*)	
77	UInt	Controller compatibility code	
78	UInt	Current scale ratio (0.1 %)	
79	UInt	Current sensor max	
80	Word	*(Not significant)*	1
81	UInt	Current range max (x 0.1 A)	
82-94		*(Not significant)*	
95	UInt	Load CT ratio (x 0.1 A)	
96	UInt	Full load current max (maximum FLC range, *FLC = Full Load Current*) (x 0.1 A)	
97-99		*(Forbidden)*	

Statistics Variables

Statistics Overview

Statistics variables are grouped according to the following criteria. Trip statistics are contained into a main table and an extension table.

Statistics variable groups	Registers
Global statistics	100 to 121
LTM monitoring statistics	122 to 149
Last trip statistics and extension	150 to 179 300 to 309
Trip n-1 statistics and extension	180 to 209 330 to 339
Trip n-2 statistics and extension	210 to 239 360 to 369
Trip n-3 statistics and extension	240 to 269 390 to 399
Trip n-4 statistics and extension	270 to 299 420 to 429

Global Statistics The global statistics are described below:

Register	Variable type	Read-only variables	*Note, p. 455*
100-101		*(Not significant)*	
102	UInt	Ground current faults count	
103	UInt	Thermal overload faults count	
104	UInt	Long start faults count	
105	UInt	Jam faults count	
106	UInt	Current phase imbalance faults count	
107	UInt	Undercurrent faults count	
109	UInt	HMI port faults count	
110	UInt	Controller internal faults count	
111	UInt	Internal port faults count	
112	UInt	Network port internal faults count	
113	UInt	Network port config faults count	
114	UInt	Network port faults count	
115	UInt	Auto-reset count	
116	UInt	Thermal overload warnings count	
117-118	UDInt	Motor starts count	
119-120	UDInt	Operating time (s)	
121	Int	Controller internal temperature max (°C)	

LTM Monitoring Statistics

The LTM monitoring statistics are described below:

Register	Variable type	Read-only variables	*Note, p. 455*
122	UInt	Faults count	
123	UInt	Warnings count	
124-125	UDInt	Motor LO1 starts count	
126-127	UDInt	Motor LO2 starts count	
128	UInt	Diagnostic faults count	
129	UInt	*(Reserved)*	
130	UInt	Overcurrent faults count	
131	UInt	Current phase loss faults count	
132	UInt	Motor temperature sensor faults count	
133	UInt	Voltage phase imbalance faults count	1
134	UInt	Voltage phase loss faults count	1
135	UInt	Wiring faults count	1
136	UInt	Undervoltage faults count	1
137	UInt	Overvoltage faults count	1
138	UInt	Underpower faults count	1
139	UInt	Overpower faults count	1
140	UInt	Under power factor faults count	1
141	UInt	Over power factor faults count	1
142	UInt	Load sheddings count	1
143-144	UDInt	Active power consumption (kWh)	1
145-146	UDInt	Reactive power consumption (kVARh)	1
147-149	UInt	*(Not significant)*	

Last Fault (n-0) Statistics

The last fault statistics are completed by variables at addresses 300 to 319.

Register	Variable type	Read-only variables	*Note, p. 455*
150	UInt	Fault code n-0	
151	UInt	Motor full load current ratio n-0 (% FLC max)	
152	UInt	Thermal capacity level n-0 (% trip level)	
153	UInt	Average current ratio n-0 (% FLC)	
154	UInt	L1 current ratio n-0 (% FLC)	
155	UInt	L2 current ratio n-0 (% FLC)	
156	UInt	L3 current ratio n-0 (% FLC)	
157	UInt	Ground current ratio n-0 (% FLC min)	
158	UInt	Full load current max n-0 (x 0.1 A)	
159	UInt	Current phase imbalance n-0 (%)	
160	UInt	Frequency n-0 (x 0.1 Hz)	
161	UInt	Motor temperature sensor n-0	
162-165	Word[4]	Date and time n-0 (See *DT_DateTime, p. 460*)	
166	UInt	Average voltage n-0 (V)	1
167	UInt	L3-L1 voltage n-0 (V)	1
168	UInt	L1-L2 voltage n-0 (V)	1
169	UInt	L2-L3 voltage n-0 (V)	1
170	UInt	Voltage phase imbalance n-0 (%)	1
171	UInt	Active power n-0	1
172	UInt	Power factor n-0 (x 0.01)	1
173-179		*(Not significant)*	

N-1 Fault Statistics

The n-1 fault statistics are completed by variables at addresses 330 to 339.

Register	Variable type	Read-only variables	*Note, p. 455*
180	UInt	Fault code n-1	
181	UInt	Motor full load current ratio n-1 (% FLC max)	
182	UInt	Thermal capacity level n-1 (% trip level)	
183	UInt	Average current ratio n-1 (% FLC)	
184	UInt	L1 current ratio n-1 (% FLC)	
185	UInt	L2 current ratio n-1 (% FLC)	
186	UInt	L3 current ratio n-1 (% FLC)	
187	UInt	Ground current ratio n-1 (% FLC min)	
188	UInt	Full load current max n-1 (x 0.1 A)	
189	UInt	Current phase imbalance n-1 (	
190	UInt	Frequency n-1 (x 0.1 Hz)	
191	UInt	Motor temperature sensor n-1 (%)	
192-195	Word[4]	Date and time n-1 (See *DT_DateTime, p. 460*)	
196	UInt	Average voltage n-1 (V)	1
197	UInt	L3-L1 voltage n-1 (V)	1
198	UInt	L1-L2 voltage n-1 (V)	1
199	UInt	L2-L3 voltage n-1 (V)	1
200	UInt	Voltage phase imbalance n-1 (x 1 %)	1
201	UInt	Active power n-1	1
202	UInt	Power factor n-1 (x 0.01)	1
203-209	UInt	*(Not significant)*	

N-2 Fault Statistics

The n-2 fault statistics are completed by variables at addresses 360 to 369.

Register	Variable type	Read-only variables	*Note, p. 455*
210	UInt	Fault code n-2	
211	UInt	Motor full load current ratio n-2 (% FLC max)	
212	UInt	Thermal capacity level n-2 (% trip level)	
213	UInt	Average current ratio n-2 (% FLC)	
214	UInt	L1 current ratio n-2 (% FLC)	
215	UInt	L2 current ratio n-2 (% FLC)	
216	UInt	L3 current ratio n-2 (% FLC)	
217	UInt	Ground current ratio n-2 (% FLC min)	
218	UInt	Full load current max n-2 (x 0.1 A)	
219	UInt	Current phase imbalance n-2 (%)	
220	UInt	Frequency n-2 (x 0.1 Hz)	
221	UInt	Motor temperature sensor n-2 (%)	
222-225	Word[4]	Date and time n-2 (See *DT_DateTime, p. 460*)	
226	UInt	Average voltage n-2 (V)	1
227	UInt	L3-L1 voltage n-2 (V)	1
228	UInt	L1-L2 voltage n-2 (V)	1
229	UInt	L2-L3 voltage n-2 (V)	1
230	UInt	Voltage phase imbalance n-2 (%)	1
231	UInt	Active power n-2	1
232	UInt	Power factor n-2 (x 0.01)	1
233-239		*(Not significant)*	

N-3 Fault Statistics

The n-3 fault statistics are completed by variables at addresses 390 to 399.

Register	Variable type	Read-only variables	*Note, p. 455*
240	UInt	Fault code n-3	
241	UInt	Motor full load current ratio n-3 (% FLC max)	
242	UInt	Thermal capacity level n-3 (% trip level)	
243	UInt	Average current ratio n-3 (% FLC)	
244	UInt	L1 current ratio n-3 (% FLC)	
245	UInt	L2 current ratio n-3 (% FLC)	
246	UInt	L3 current ratio n-3 (% FLC)	
247	UInt	Ground current ratio n-3 (% FLC min)	
248	UInt	Full load current max n-3 (0.1 A)	
249	UInt	Current phase imbalance n-3 (%)	
250	UInt	Frequency n-3 (x 0.1 Hz)	
251	UInt	Motor temperature sensor n-3 (%)	
252-255	Word[4]	Date and time n-3 (See *DT_DateTime, p. 460*)	
256	UInt	Average voltage n-3 (V)	1
257	UInt	L3-L1 voltage n-3 (V)	1
258	UInt	L1-L2 voltage n-3 (V)	1
259	UInt	L2-L3 voltage n-3 (V)	1
260	UInt	Voltage phase imbalance n-3 (%)	1
261	UInt	Active power n-3	1
262	UInt	Power factor n-3 (x 0.01)	1
263-269		*(Not significant)*	

N-4 Fault Statistics

The n-4 fault statistics are completed by variables at addresses 420 to 429.

Register	Variable type	Read-only variables	*Note, p. 455*
270	UInt	Fault code n-4	
271	UInt	Motor full load current ratio n-4 (% FLC max)	
272	UInt	Thermal capacity level n-4 (% trip level)	
273	UInt	Average current ratio n-4 (% FLC)	
274	UInt	L1 current ratio n-4 (% FLC)	
275	UInt	L2 current ratio n-4 (% FLC))	
276	UInt	L3 current ratio n-4 (% FLC)	
277	UInt	Ground current ratio n-4 (% FLC)	
278	UInt	Full load current max n-4 (x 0.1 A)	
279	UInt	Current phase imbalance n-4 (%)	
280	UInt	Frequency n-4 (x 0.1 Hz)	
281	UInt	Motor temperature sensor n-4 (%)	
282-285	Word[4]	Date and time n-4 (See *DT_DateTime, p. 460*)	
286	UInt	Average voltage n-4 (V)	1
287	UInt	L3-L1 voltage n-4 (V)	1
288	UInt	L1-L2 voltage n-4 (V)	1
289	UInt	L2-L3 voltage n-4 (V)	1
290	UInt	Voltage phase imbalance n-4 (%)	1
291	UInt	Active power n-4	1
292	UInt	Power factor n-4 (x 0.01)	1
293-299		*(Not significant)*	

Last Fault (n-0) Statistics Extension

The last fault main statistics are listed at addresses 150-179.

Register	Variable type	Read-only variables	*Note, p. 455*
300-301	UDInt	Average current n-0	
302-303	UDInt	L1 current n-0	
304-305	UDInt	L2 current n-0	
306-307	UDInt	L3 current n-0	
308-309	UDInt	Ground current n-0	

N-1 Fault Statistics Extension

The n-1 fault main statistics are listed at addresses 180-209.

Register	Variable type	Read-only variables	*Note, p. 455*
330-331	UDInt	Average current n-1	
332-333	UDInt	L1 current n-1	
334-335	UDInt	L2 current n-1	
336-337	UDInt	L3 current n-1	
338-339	UDInt	Ground current n-1	

N-2 Fault Statistics Extension

The n-2 fault main statistics are listed at addresses 210-239.

Register	Variable type	Read-only variables	*Note, p. 455*
360-361	UDInt	Average current n-2	
362-363	UDInt	L1 current n-2	
364-365	UDInt	L2 current n-2	
366-367	UDInt	L3 current n-2	
368-369	UDInt	Ground current n-2	

N-3 Fault Statistics Extension

The n-3 fault main statistics are listed at addresses 240-269.

Register	Variable type	Read-only variables	*Note, p. 455*
390-391	UDInt	Average current n-3	
392-393	UDInt	L1 current n-3	
394-395	UDInt	L2 current n-3	
396-397	UDInt	L3 current n-3	
398-399	UDInt	Ground current n-3	

N-4 Fault Statistics Extension

The n-4 fault main statistics are listed at addresses 270-299.

Register	Variable type	Read-only variables	*Note, p. 455*
420-421	UDInt	Average current n-4	
422-423	UDInt	L1 current n-4	
424-425	UDInt	L2 current n-4	
426-427	UDInt	L3 current n-4	
428-429	UDInt	Ground current n-4	

Monitoring Variables

Monitoring Variables

Monitoring variables are described below:

Monitoring variable groups	Registers
Monitoring of faults	450 to 454
Monitoring of status	455 to 459
Monitoring of warnings	460 to 464
Monitoring of measurements	465 to 539

Register	Variable type	Read-only variables	*Note, p. 455*
450	UInt	Minimum wait time (s)	
451	UInt	Fault code (code of the last fault, or of the fault that takes priority) (See *DT_ExtOperatingMode, p. 461*.)	
452	Word	Fault register 1	
		bits 0-1 *(Reserved)*	
		bit 2 Ground current fault	
		bit 3 Thermal overload fault	
		bit 4 Long start fault	
		bit 5 Jam fault	
		bit 6 Current phase imbalance fault	
		bit 7 Undercurrent fault	
		bit 8 *(Reserved)*	
		bit 9 Test fault	
		bit 10 HMI port fault	
		bit 11 Controller internal fault	
		bit 12 Internal port fault	
		bit 13 Network port internal fault	
		bit 14 Network port config fault	
		bit 15 Network port fault	

Register	Variable type	Read-only variables	*Note, p. 455*
453	Word	Fault register 2	
		bit 0 *(Not significant)*	
		bit 1 Diagnostic fault	
		bit 2 Wiring fault	
		bit 3 Overcurrent fault	
		bit 4 Current phase loss fault	
		bit 5 Current phase reversal fault	
		bit 6 Motor temperature sensor fault	1
		bit 7 Voltage phase imbalance fault	1
		bit 8 Voltage phase loss fault	1
		bit 9 Voltage phase reversal fault	1
		bit 10 Undervoltage fault	1
		bit 11 Overvoltage fault	1
		bit 12 Underpower fault	1
		bit 13 Overpower fault	1
		bit 14 Under power factor fault	1
		bit 15 Over power factor fault	1
454		*(Reserved)*	
455	Word	System status register 1	
		bit 0 System ready	
		bit 1 System on	
		bit 2 System fault	
		bit 3 System warning	
		bit 4 System tripped	
		bit 5 Fault reset authorized	
		bit 6 Controller power	
		bit 7 Motor running (with detection of a current, if greater than 10% FLC)	
		bits 8-13 Motor average current ratio 32 = 100% FLC - 63 = 200% FLC	
		bit 14 Control via HMI	
		bit 15 Motor starting (start in progress) 1 = ascending current is greater than 10% FLC 0 = descending current is less than 150% FLC	

Register	Variable type	Read-only variables	*Note, p. 455*
456	Word	System status register 2	
		bit 0 Auto-reset active	
		bit 1 *(Not significant)*	
		bit 2 Fault power cycle requested	
		bit 3 Motor restart time undefined	
		bit 4 Rapid cycle lockout	
		bit 5 Load shedding	1
		bit 6 Motor speed	
		bit 7 HMI port comm loss	
		bit 8 Network port comm loss	
		bit 9 Motor transition lockout	
		bits 10-15 (Not significant)	
457	Word	Logic inputs status	
		bit 0 Logic input 1	
		bit 1 Logic input 2	
		bit 2 Logic input 3	
		bit 3 Logic input 4	
		bit 4 Logic input 5	
		bit 5 Logic input 6	
		bit 6 Logic input 7	
		bit 7 Logic input 8	1
		bit 8 Logic input 9	1
		bit 9 Logic input 10	1
		bit 10 Logic input 11	1
		bit 11 Logic input 12	1
		bit 12 Logic input 13	1
		bit 13 Logic input 14	1
		bit 14 Logic input 15	1
		bit 15 Logic input 16	1

Register	Variable type	Read-only variables	*Note, p. 455*
458	Word	Logic outputs status	
		bit 0 Logic output 1	
		bit 1 Logic output 2	
		bit 2 Logic output 3	
		bit 3 Logic output 4	
		bit 4 Logic output 5	1
		bit 5 Logic output 6	1
		bit 6 Logic output 7	1
		bit 7 Logic output 8	1
		bits 8-15 (Reserved)	
459	Word	I/O status	
		bit 0 Input 1	
		bit 1 Input 2	
		bit 2 Input 3	
		bit 3 Input 4	
		bit 4 Input 5	
		bit 5 Input 6	
		bit 6 Input 7	
		bit 7 Input 8	
		bit 8 Input 9	
		bit 9 Input 10	
		bit 10 Input 11	
		bit 11 Input 12	
		bit 12 Output 1 (13-14)	
		bit 13 Output 2 (23-24)	
		bit 14 Output 3 (33-34)	
		bit 15 Output 4 (95-96, 97-98)	
460	UInt	Warning code	

Register	Variable type	Read-only variables	*Note, p. 455*
461	Word	Warning register 1	
		bits 0-1 (Not significant)	
		bit 2 Ground current warning	
		bit 3 Thermal overload warning	
		bit 4 (Not significant)	
		bit 5 Jam warning	
		bit 6 Current phase imbalance warning	
		bit 7 Undercurrent warning	
		bits 8-9 (Not significant)	
		bit 10 HMI port warning	
		bit 11 Controller internal temperature warning	
		bit 12 Internal port warning	
		bits 13-14 (Not significant)	
		bit 15 Network port warning	
462	Word	Warning register 2	
		bit 0 (Not significant)	
		bit 1 Diagnostic warning	
		bit 2 (Reserved)	
		bit 3 Overcurrent warning	
		bit 4 Current phase loss warning	
		bit 5 Current phase reversal warning	
		bit 6 Motor temperature sensor warning	
		bit 7 Voltage phase imbalance warning	1
		bit 8 Voltage phase loss warning	1
		bit 9 Voltage phase reversal warning	1
		bit 10 Undervoltage warning	1
		bit 11 Overvoltage warning	1
		bit 12 Underpower warning	1
		bit 13 Overpower warning	1
		bit 14 Under power factor warning	1
		bit 15 Over power factor warning	1
463-464		*(Not significant)*	
465	UInt	Thermal capacity level (% trip level)	
466	UInt	Average current ratio (% FLC)	

Register	Variable type	Read-only variables	*Note, p. 455*
467	UInt	L1 current ratio (% FLC)	
468	UInt	L2 current ratio (% FLC)	
469	UInt	L3 current ratio (% FLC)	
470	UInt	Ground current ratio (x 0.1 % FLC min)	
471	UInt	Current phase imbalance (%)	
472	Int	Controller internal temperature (°C)	
473	UInt	Controller config checksum	
474	UInt	Frequency (x 0.01 Hz)	
475	UInt	Motor temperature sensor (%)	
476	UInt	Average voltage (V)	1
477	UInt	L3-L1 voltage (V)	1
478	UInt	L1-L2 voltage (V)	1
479	UInt	L2-L3 voltage (V)	1
480	UInt	Voltage phase imbalance (%)	1
481	UInt	Power factor (x 0.01)	1
482	UInt	Active power consumption	1
483	UInt	Reactive power consumption (kVAR)	1
484-489	Word	*(Not significant)*	
490	Word	Network port status	
		bit 0 Network port communicating	
		bit 1 Network port connected	
		bit 2 Network port self-testing	
		bit 3 Network port self-detecting	
		bit 4 Network port bad config	
		bits 5-15 (Not significant)	
491-499	Word	*(Not significant)*	
500-501	UDInt	Average current (x 0.01 A)	
502-503	UDInt	L1 current (x 0.01 A)	
504-505	UDInt	L2 current (x 0.01 A)	
506-507	UDInt	L3 current (x 0.01 A)	
508-509	UDInt	Ground current (x 0.01 A)	
510	UInt	Controller port ID	
511	UInt	Time to trip (x 1 s)	
512	UInt	Motor last start current ratio (% FLC)	

Register	Variable type	Read-only variables	*Note, p. 455*
513	UInt	Motor last start duration (s)	
514	UInt	Motor starts per hour count	
515	Word	Phase imbalances register	
		bit 0 L1 current highest imbalance	
		bit 1 L2 current highest imbalance	
		bit 2 L3 current highest imbalance	
		bit 3 L1-L2 voltage highest imbalance	1
		bit 4 L2-L3 voltage highest imbalance	1
		bit 5 L3-L1 voltage highest imbalance	1
		bits 6-15 (Not significant)	
516 - 523		*(Reserved)*	
524 - 539		*(Forbidden)*	

Configuration Variables

Configuration Variables

Configuration variables are described below:

Configuration variable groups	Registers
Configuration	540 to 649
Setting	650 to 699

Register	Variable type	Read / Write variables	*Note, p. 455*
540	UInt	Motor operating mode (See *DT_ExtOperatingMode, p. 461*)	B
541	UInt	Motor transition timeout (s)	
542-545		*(Reserved)*	
546	UInt	Thermal overload configuration	B
		bits 0-2 Motor temperature sensor type: 0 = None 1 = PTC binary 3 = PTC analog 4 = NTC analog	
		bits 3-4 Thermal overload mode: 0 = Definite 1 = Inverse thermal	
		bits 5-15 (Reserved)	
547	UInt	Thermal overload fault definite timeout	
548		*(Reserved)*	
549	UInt	Motor temperature sensor fault threshold (x 0.1 ohm)	
550	UInt	Motor temperature sensor warning threshold (x 0.1 ohm)	
551-552		*(Reserved)*	
553	UInt	Rapid cycle lockout timeout (s)	
554		*(Reserved)*	
555	UInt	Current phase loss timeout	
556	UInt	Overcurrent fault timeout	
557	UInt	Overcurrent fault threshold	
558	UInt	Overcurrent warning threshold	
559	Word	Ground current fault configuration	B
		bit 0 Ground current mode	
		bits 1-15 (Reserved)	

Register	Variable type	Read / Write variables	*Note, p. 455*
560	UInt	Ground CT primary	
561	UInt	Ground CT secondary	
562	UInt	External ground current fault timeout	
563	UInt	External ground current fault threshold	
564	UInt	External ground current warning threshold	
565	UInt	Motor nominal voltage	1
566	UInt	Voltage phase imbalance fault timeout starting	1
567	UInt	Voltage phase imbalance fault timeout running	1
568	UInt	Voltage phase imbalance fault threshold	1
569	UInt	Voltage phase imbalance warning threshold	1
570	UInt	Overvoltage fault timeout	1
571	UInt	Overvoltage fault threshold	1
572	UInt	Overvoltage warning threshold	1
573	UInt	Undervoltage fault timeout	1
574	UInt	Undervoltage fault threshold	1
575	UInt	Undervoltage warning threshold	1
576	UInt	Voltage phase loss fault timeout	1
577	Word	Voltage load shedding configuration	1
		bit 0 Load shedding enable	
		bits 1-15 (Reserved)	
578	UInt	Load shedding timeout	1
579	UInt	Load shedding threshold	1
580	UInt	Load shedding restart timeout	1
581	UInt	Load shedding restart threshold	1
582		*(Reserved)*	
583	UInt	Motor nominal power	1
584	UInt	Overpower fault timeout	1
585	UInt	Overpower fault threshold	1
586	UInt	Overpower warning threshold	1
587	UInt	Underpower fault timeout	1
588	UInt	Underpower fault threshold	1
589	UInt	Underpower warning threshold	1
590	UInt	Under power factor fault timeout	1
591	UInt	Under power factor fault threshold	1

Register	Variable type	Read / Write variables	*Note, p. 455*
592	UInt	Under power factor warning threshold	1
593	UInt	Over power factor fault timeout	1
594	UInt	Over power factor fault threshold	1
595	UInt	Over power factor warning threshold	1
596-599		*(Reserved)*	
600	UInt	HMI keypad password	
601	Word	General configuration register 1	
		bit 0 Controller system config required: 0 = exit the configuration menu 1 = go to the configuration menu	A
		bits 1-7 (Reserved)	
		Control mode configuration, bits 8-10 (one bit is set to 1):	
		bit 8 Config via HMI keypad enable	
		bit 9 Config via HMI engineering tool enable	
		bit 10 Config via network port enable	
		bit 11 (Not significant)	
		bit 12 Motor phases sequence: 0 = A B C 1 = A C B	
		bits 13-14 Motor phases 1 = 3-phase (default) 2 = 1-phase	A
		bit 15 Motor auxiliary fan cooled (default = 0)	
602	Word	General configuration register 2	
		bits 0-2 Fault reset mode: 1 = Manual (default) 2 = Remote (or control unit keypad) 4 = Automatic	C
		bit 3 HMI port parity setting: 0 = none (default) 1 = even	
		bits 4-8 *(Reserved)*	
		bit 9 HMI port endian setting	
		bit 10 Network port endian setting	
		bits 11-15 *(Reserved)*	
603	UInt	HMI port address setting	
604	UInt	HMI port baud rate setting	

Register	Variable type	Read / Write variables	*Note, p. 455*
605		*(Reserved)*	
606	UInt	Motor trip class	
607		*(Reserved)*	
608	UInt	Thermal overload fault reset threshold	
609	UInt	Thermal overload warning threshold	
610	UInt	Internal ground current fault timeout	
611	UInt	Internal ground current fault threshold	
612	UInt	Internal ground current warning threshold	
613	UInt	Current phase imbalance fault timeout starting	
614	UInt	Current phase imbalance fault timeout running	
615	UInt	Current phase imbalance fault threshold	
616	UInt	Current phase imbalance warning threshold	
617	UInt	Jam fault timeout	
618	UInt	Jam fault threshold	
619	UInt	Jam warning threshold	
620	UInt	Undercurrent fault timeout	
621	UInt	Undercurrent fault threshold	
622	UInt	Undercurrent warning threshold	
623	UInt	Long start fault timeout	
624	UInt	Long start fault threshold	
625		*(Reserved)*	
626	UInt	HMI display contrast setting	
627	UInt	Contactor rating	
628	UInt	Load CT primary	B
629	UInt	Load CT secondary	B
630	UInt	Load CT multiple passes	B

Register	Variable type	Read / Write variables	*Note, p. 455*
631	Word	Fault enable register 1	
		bits 0-1 *(Reserved)*	
		bit 2 Ground current fault enable	
		bit 3 Thermal overload fault enable	
		bit 4 Long start fault enable	
		bit 5 Jam fault enable	
		bit 6 Current phase imbalance fault enable	
		bit 7 Undercurrent fault enable	
		bit 8 *(Reserved)*	
		bit 9 Test fault enable	
		bit 10 HMI port fault enable	
		bits 11-14 *(Reserved)*	
		bit 15 Network port fault enable	
632	Word	Warning enable register 1	
		bit 0 *(Not significant)*	
		bit 1 *(Reserved)*	
		bit 2 Ground current warning enable	
		bit 3 Thermal overload warning enable	
		bit 4 *(Reserved)*	
		bit 5 Jam warning enable	
		bit 6 Current phase imbalance warning enable	
		bit 7 Undercurrent warning enable	
		bits 8- 9 *(Reserved)*	
		bit 10 HMI port warning enable	
		bit 11 Controller internal temperature warning enable	
		bits 12-14 *(Reserved)*	
		bit 15 Network port warning enable	

Register	Variable type	Read / Write variables	*Note, p. 455*
633	Word	Fault enable register 2	
		bit 0 *(Reserved)*	
		bit 1 Diagnostic fault enable	
		bit 2 Wiring fault enable	
		bit 3 Overcurrent fault enable	
		bit 4 Current phase loss fault enable	
		bit 5 Current phase reversal fault enable	
		bit 6 Motor temperature sensor fault enable	
		bit 7 Voltage phase imbalance fault enable	1
		bit 8 Voltage phase loss fault enable	1
		bit 9 Voltage phase reversal fault enable	1
		bit 10 Undervoltage fault enable	1
		bit 11 Overvoltage fault enable	1
		bit 12 Underpower fault enable	1
		bit 13 Overpower fault enable	1
		bit 14 Under power factor fault enable	1
		bit 15 Over power factor fault enable	1
634	Word	Warning enable register 2	
		bit 0 *(Reserved)*	
		bit 1 Diagnostic warning enable	
		bit 2 *(Reserved)*	
		bit 3 Overcurrent warning enable	
		bit 4 Current phase loss warning enable	
		bit 5 *(Reserved)*	
		bit 6 Motor temperature sensor warning enable	
		bit 7 Voltage phase imbalance warning enable	1
		bit 8 Voltage phase loss warning enable	1
		bit 9 *(Reserved)*	1
		bit 10 Undervoltage warning enable	1
		bit 11 Overvoltage warning enable	1
		bit 12 Underpower warning enable	1
		bit 13 Overpower warning enable	1
		bit 14 Under power factor warning enable	1
		bit 15 Over power factor warning enable	1

Register	Variable type	Read / Write variables	*Note, p. 455*
635-6		*(Reserved)*	
637	UInt	Auto-reset attempts group 1 setting	
638	UInt	Auto-reset group 1 timeout	
639	UInt	Auto-reset attempts group 2 setting	
640	UInt	Auto-reset group 2 timeout	
641	UInt	Auto-reset attempts group 3 setting	
642	UInt	Auto-reset group 3 timeout	
643	UInt	Motor step 1 to 2 timeout	
644	UInt	Motor step 1 to 2 threshold	
645	UInt	HMI port fallback setting	
646-649		*(Reserved)*	
650	Word	HMI language setting:	
		bit 0 1 = English (default)	
		bit 1 2 = Français	
		bit 2 4 = Español	
		bit 3 8 = Deutsch	
		bit 4 16 = Italiano	
		bits 5-15 *(Not significant)*	

Register	Variable type	Read / Write variables	*Note, p. 455*
651	Word	HMI display items register 1	
		bit 0 HMI display average current enable	
		bit 1 HMI display thermal capacity level enable	
		bit 2 HMI display L1 current enable	
		bit 3 HMI display L2 current enable	
		bit 4 HMI display L3 current enable	
		bit 5 HMI display ground current enable	
		bit 6 HMI display last fault enable	
		bit 7 HMI display current phase imbalance enable	
		bit 8 *(Not significant)*	
		bit 9 HMI display I/O status enable	
		bit 10 HMI display reactive power enable	
		bit 11 HMI display frequency enable	
		bit 12 HMI display starts per hour enable	
		bit 13 HMI display definite overcurrent ratio enable	
		bit 14 HMI display max current phase enable	
		bit 15 HMI motor temperature sensor enable	
652	UInt	Motor full load current ratio	
653	UInt	Motor high speed full load current ratio	

Register	Variable type	Read / Write variables	*Note, p. 455*
654	Word	HMI display items register 2	
		bit 0 HMI display L1-L2 voltage enable	1
		bit 1 HMI display L2-L3 voltage enable	1
		bit 2 HMI display L3-L1 voltage enable	1
		bit 3 HMI display average voltage enable	1
		bit 4 HMI display active power enable	1
		bit 5 HMI display power consumption enable	1
		bit 6 HMI display power factor enable	1
		bit 7 HMI display average current ratio enable	
		bit 8 HMI display L1 current ratio enable	1
		bit 9 HMI display L2 current ratio enable	1
		bit 10 HMI display L3 current ratio enable	1
		bit 11 HMI display thermal capacity remaining enable	
		bit 12 HMI display time to trip enable	
		bit 13 HMI display voltage phase imbalance enable	1
		bit 14 HMI display date enable	
		bit 15 HMI display time enable	
655-658	Word[4]	Date and time setting (See *DT_DateTime, p. 460*)	
659-681		*(Reserved)*	
682	UInt	Network port fallback setting	
683	UInt	Control setting register	
		bits 0-7 *(Reserved)*	
		bit 8 Control local channel setting: 0 = local HMI 1 = terminal strip	
		bit 9 Control direct transition	
		bit 10 Bumpless transfer mode: 0 = bump 1 = bumpless	
		bits 11-15 *(Not significant)*	
684-692		*(Forbidden*	
693	UInt	Network port comm loss timeout (Modbus only)	
694	UInt	Network port parity setting (Modbus only)	
695	UInt	Network port baud rate setting	

Register	Variable type	Read / Write variables	*Note, p. 455*
696	UInt	Network port address setting	
697-699		*(Not significant)*	

Command Variables

Command Variables

Command variables are described below:

Register	Variable type	Read / Write variables	*Note, p. 455*
700	Word	Logic outputs command register	
		bit 0 Logic output 1 command	
		bit 1 Logic output 2 command	
		bit 2 Logic output 3 command	
		bit 3 Logic output 4 command	
		bit 4 Logic output 5 command	1
		bit 5 Logic output 6 command	1
		bit 6 Logic output 7 command	1
		bit 7 Logic output 8 command	1
		bits 8-15 (Reserved)	
701-703		*(Reserved)*	
704	Word	Control register 1	
		bit 0 Motor run forward command	
		bit 1 Motor run reverse command	
		bit 2 (Reserved)	
		bit 3 Fault reset command	
		bit 4 (Reserved)	
		bit 5 Self test command	
		bit 6 Motor low speed command	
		bits 7-15 (Reserved)	
705	Word	Control register 2	
		bit 0 Clear all command	
		bit 1 Clear statistics command	
		bit 2 Clear thermal capacity level command	
		bit 3 Clear controller settings command	
		bit 4 Clear network port settings command	
		bits 5-15 (Reserved)	
706-709		*(Reserved)*	
710-799		*(Forbidden)*	

User Map Variables

User Map Variables

User Map variables are described below:

User map variable groups	Registers
User Map addresses	800 to 899
User Map values	900 to 999

Register	Variable type	Read/Write variables	*Note, p. 455*
800-898	Word[99]	User map addresses setting	
899		*(Reserved)*	

Register	Variable type	Read/Write variables	*Note, p. 455*
900-998	Word[99]	User map values	
999		*(Reserved)*	

Custom Logic Variables

Custom Logic Variables

Custom logic variables are described below:

Register	Variable type	Read-only variables	*Note, p. 455*
1200	Word	Custom logic status register	
		bit 0 Custom logic run	
		bit 1 Custom logic stop	
		bit 2 Custom logic reset	
		bit 3 (Reserved)	
		bit 4 Custom logic transition	
		bit 5 Custom logic phase reverse	
		bit 6 Custom logic network control	
		bit 7 Custom logic FLC selection	
		bit 8 Custom logic external fault	
		bit 9 Custom logic auxiliary 1 LED	
		bit 10 Custom logic auxiliary 2 LED	
		bit 11 Custom logic stop LED	
		bit 12 Custom logic LO1	
		bit 13 Custom logic LO2	
		bit 14 Custom logic LO3	
		bit 15 Custom logic LO4	
1201	Word	Custom logic version	
1202	Word	Custom logic memory space	
1203	Word	Custom logic memory used	
1204	Word	Custom logic temporary space	
1205	Word	Custom logic non volatile space	
1206-1300		*(Reserved)*	
1301-1399		General purpose registers for logic functions	

Maintenance

9

At a Glance

Overview

This chapter describes the maintenance and self-diagnostic features of the LTM R controller and the expansion module.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program, install, alter, and apply this product. Follow all local and national safety codes and standards.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

What's in this Chapter?

This chapter contains the following topics:

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Replacing an LTM R Controller and LTM E Expansion Module	505
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Detecting Problems

Overview

The LTM R controller and the expansion module perform self-diagnostic checks at power-up and during operation.

Problems with either the LTM R controller or expansion module can be detected using:

- Power and Alarm LEDs on the LTM R controller
- Power and Input LEDs on the expansion module
- LCD Display on a Magelis® XBTN410 HMI device connected to the LTM R controller's Local HMI port
- PowerSuite™ software running on a PC connected to the LTM R controller's Local HMI port

Device LEDs

The LEDs on the LTM R controller and expansion module will indicate the following problems:

LTM R LED			LTM E LED	Problem
Power	**Alarm**	**PLC Alarm**	**Power**	
Off	Solid red	-	-	Internal fault
On	Solid red	-	-	Protection fault
On	Flashing red (2x per second)	-	-	Protection warning
On	Flashing red (5x per second)	-	-	Load shed or rapid cycle
On	-	-	Solid red	Internal fault

HMI LCD

The Magelis® XBTN410 HMI automatically displays information about a fault or warning, including LTM R controller self-diagnostic faults and warnings, when it occurs.

For information about the display of faults and warnings when the HMI is used in a 1-to-1 configuration, see *p. 386*.

For information about the display of faults and warnings when the HMI is used in a 1-to-many configuration, see *p. 424*.

PowerSuite™

PowerSuite™ software displays a visual array of active faults and warnings, including LTM R controller self-diagnostic faults and warnings, when these faults occur.

For information about this display of active faults and warnings, see *p. 442*.

Troubleshooting

The LTM R controller performs self-diagnostic tests at power-up and during operation. These tests, the errors they detect, and the steps to take in response to a problem are described below:

Type	Error	Action
Major internal faults	Internal temperature fault	This fault indicates a warning at 80°C, a minor fault at 85°C, and a major fault at 100°C. Take steps to reduce ambient temperature, including: • add an auxiliary cooling fan • remount the LTM R controller and expansion module to provide more surrounding free space. If the condition persists: **1** Cycle power. **2** Wait 30 s. **3** If the fault persists, replace the LTM R controller.
	CPU failure	These faults indicate a hardware failure. Take the following steps: **1** Cycle power. **2** Wait 30 s. **3** If the fault persists, replace the LTM R controller.
	Program checksum error	
	RAM test error	
	Stack overflow	
	Stack underflow	
	Watchdog timeout	
Minor internal faults	Invalid configuration error	Indicates either a bad checksum (Config checksum error) or good checksum but bad data (Invalid config error). Both caused by hardware failure. Take the following steps: **1** Cycle power and wait 30 s. **2** Reset the configuration settings to factory defaults. **3** If the fault persists, replace the LTM R controller.
	Configuration checksum (EEROM) error	
	Internal network communications failure	These faults indicate a hardware failure. Take the following steps: **1** Cycle power and wait 30 s. **2** If the fault persists, replace the LTM R controller.
	A/D out of range error	

Type	Error	Action

Diagnostic errors	Start command check	Check the following:
		● relay outputs
		● all wiring, including:
		  ● control wiring circuit, including all electromechanical devices
		  ● power wiring circuit, including all components
		  ● load CT wiring.
		
		After all checks are complete:
		1 Reset the fault.
		2 If the fault persists, cycle power and wait 30 s.
		3 If the fault persists, replace the LTM R controller.

	Stop command check	
	Stop check back	
	Run check back	

Type	Error	Action
Wiring/ config errors	CT reversal error	Correct the polarity of the CTs. Be sure that: • all external CTs face the same direction • all load CT wiring passes through windows in the same direction After the check is complete: **1** Perform a fault reset. **2** If the fault persists, cycle power and wait 30 s. **3** If the fault still persists, replace the LTM R controller.
	Current/Voltage phase reversal error Phase configuration error	Check: • L1, L2 and L3 wiring connection to be sure wires are not crossed • Motor Phases Sequence parameter setting (ABC versus ACB) After all checks are complete: **1** Perform a fault reset. **2** If the fault persists, cycle power and wait 30 s. **3** If the fault persists, replace the LTM R controller.
	PTC connection error	Check for: • short circuit or open circuit in the motor temp sensor wiring • wrong type of motor temp sensing device • improper configuration of parameters for selected device. After all checks are complete: **1** Perform a fault reset. **2** If the fault persists, cycle power and wait 30 s. **3** If the fault persists, replace the LTM R controller.
	Voltage phase loss error	Check for: • improper wiring, such as loose terminations • blown fuse • cut wire • single-phase motor configured for 3-phase operation • failure to wire a single phase motor through both A and C load CT windows • failure of power source (for example, utility power failure). After all checks are complete: **1** Perform fault reset. **2** If the fault persists, cycle power and wait 30 s. **3** If the fault persists, replace the LTM R controller.

Preventive Maintenance

Overview

The following protective measures should be performed between major system checks, to help maintain your system and protect it against irrecoverable hardware or software failure:

- continuously review operating statistics
- save LTM R controller parameter configuration settings to a backup file
- maintain the LTM R controller's operating environment
- periodically perform a LTM R controller self test
- check the LTM R controller internal clock to ensure accuracy.

Statistics

The LTM R controller collects the following types of information:

- real-time voltage, current, power, temperature, I/O and fault data
- a count of the number of faults, by fault type, that occurred since last power-up
- a time-stamped history of the state of the LTM R controller—displaying measures of voltage, current, power, and temperature—at the moment that each of the previous 5 faults occurred.

Use either PowerSuite™ software or a Magelis® XBTN410 HMI to access and review these statistics. Analyze this information to determine whether the actual record of operations indicates a problem.

Configuration Settings

In the event of irrecoverable LTM R controller failure, you can quickly restore configuration settings if you saved these settings to a file. When the LTM R controller is first configured—and every subsequent time any configuration settings are changed—use PowerSuite software to save the parameter settings to a file.

Using PowerSuite software:

- To save a configuration file:
  1. Select File → Print → To File.
- To restore the saved configuration file:
  1. Open the saved file: Select File → Open (then navigate to and open the file.)
  2. Download the configuration to the new controller:
  Select Link → Transfer → Device to PC.

Environment

Like any other electronic device, the LTM R controller is affected by its physical environment. Provide a friendly environment by taking common-sense preventive measures, including:

- Scheduling periodic examinations of battery packs, fuses, power strips, batteries, surge suppressors, and power supplies.
- Keeping the LTM R controller, the panel, and all devices clean. An unobstructed flow of air will prevent dust build-up, which can lead to a short-circuit condition.
- Remaining alert to the possibility of other equipment producing electromagnetic radiation. Be sure no other devices cause electromagnetic interference with the LTM R controller.

Self Test

Perform a self test by either:

- holding down the Test/Reset button on the face of the LTM R controller for more than 3 seconds and up to 15 seconds, or
- setting the Self Test Command parameter.

A self test can be performed only if:

- motor is off
- no faults exist
- the Self Test Enable parameter is set

Note: Performing a self test when the motor is on triggers a Thermal Overload fault.

The LTM R controller performs the following checks during a self test:

- watchdog check
- RAM check
- recalibration of the thermal memory time constant, which keeps track of time while the LTM R controller is not powered

If any of the above tests fails, a major internal fault occurs. If not, the self test continues and the LTM R controller performs:

- expansion module test (if it is connected to an expansion module). If this test fails:
  - the LTM R controller experiences a minor internal fault
  - the expansion module experiences an internal fault
- internal communication (communication brick) test. If this test fails, the LTM R controller experiences a minor internal fault
- LED test: turns all LEDs off, then turns each LED on in sequence, then turns all LEDs on, then returns LEDs to their initial state
- output relay test: opens all relays, and restores them to their original state only after:
  - a reset command executes, or
  - power is cycled

During a self test, the LTM R controller sets the Self Test Command parameter to 1. When the self test finishes, this parameter is reset to 0.

Internal Clock

To ensure an accurate record of faults, be sure to maintain the LTM R controller's internal clock. The LTM R controller time stamps all faults, using the value stored in the Date And Time Setting parameter.

Internal clock accuracy is +/-1 second per hour. If power is continuously applied for 1 year, the internal clock accuracy is +/-30 minutes per year.

If power is turned Off for 30 minutes or less, the LTM R controller retains its internal clock settings, with accuracy of +/- 2 minutes.

If power is turned Off for more than 30 minutes, the LTM R controller resets its internal clock to the time when power was turned Off.

Replacing an LTM R Controller and LTM E Expansion Module

Overview

Questions to consider in advance of replacing either an LTM R controller or an LTM E expansion module are:

- is the replacement device the same model as the original?
- have the configuration settings of the LTM R controller been saved, and are they available to be transferred to its replacement?

Be sure the motor is turned off before replacing either the LTM R controller or the LTM E expansion module.

Replacing the LTM R Controller

The time to plan for the replacement of an LTM R controller is:

- when the LTM R controller settings are initially configured, and
- any time that one or more of its settings are subsequently re-configured

Because setting values may not be accessible when the LTM R controller is replaced–for example, in case of device failure–you should create a record of setting values whenever they are made.

Using PowerSuite™ software, all of the LTM R controller's configured settings—except for date and time—can be saved to a file. Once saved, you can use PowerSuite software to transfer these settings either to the original LTM R controller or to its replacement.

Note: Only configured settings are saved. Historical statistical data is not saved, and therefore cannot be applied to a replacement LTM R controller.

For information on how to use PowerSuite software to create, save and transfer configuration setting files, see *p. 430*.

Replacing the Expansion Module

The primary consideration in replacing an LTM E expansion module, is to replace it with the same model–24Vdc or 110-240Vac–as the original.

Retiring Devices

Both the LTM R controller and the LTM E expansion module contain electronic boards that require particular treatment at the end of their useful life. When retiring a device be sure to observe all applicable laws, regulations and practices.

Communication Warnings and Faults

Introduction

Communication warnings and faults are managed in a standard way, like any other types of warnings and faults.

The presence of a fault is signalled by various indicators:

- State of the LEDs (1 LED is dedicated to communication: **PLC Comm**, see *p. 330*)
- State of the output relays
- Warning
- Message(s) displayed on HMI screen
- Presence of an exception code (such as a report from the PLC)

PLC Communication Loss

A communication loss is managed like any other fault.

The LTM R controller monitors the communication with the PLC. Using an adjustable network idle time (timeout), the LTM R controller watchdog function can report a network loss (firmware watchdog). In the event of a network loss, the LTM R controller can be configured to take certain actions. These depend on the control mode that the LTM R controller was operating in prior to the network loss.

If PLC-LTM R controller communication is lost while the LTM R controller is in network control mode, the LTM R controller enters the fallback state. If PLC- LTM R controller communication is lost while the LTM R controller is in local control mode, and then the control mode is changed to network control, the LTM R controller enters the fallback state.

If PLC-LTM R controller communication is restored while the control mode is set to network control, the LTM R controller exits the fallback state. If the control mode is changed to local control, the IMPR exits from the fallback state, regardless of the state of PLC-controller communications.

The table below defines the available actions that the LTM R controller may take during a communication loss that the user may select when configuring the LTM R controller.

Network Communication Loss Actions:

LTM R controller output control mode prior to network loss	Available LTM R actions after PLC - LTM R controller network loss
Local Terminal Strip	Fault and Warning control possibilities: - Signal nothing - Activate a warning - Activate a fault - Activate a fault and warning
Local RJ45	Fault and Warning control possibilities: - Signal nothing - Activate a warning - Activate a fault - Activate a fault and warning
Remote	Fault and Warning control possibilities: - Signal nothing - Activate a warning - Activate a fault - Activate a fault and warning - The behavior of the LO1 and LO2 relays depends on the motor controller mode and on the fallback strategy chosen

HMI Communication Loss

The LTM R controller monitors the communication with any approved HMI device. Using a fixed network idle time (timeout), the LTM R controller watchdog function can report a network loss. In the event of a communication loss, the LTM R controller can be configured to take certain actions. These depend on the control mode that the LTM R controller was operating in prior to the communication loss.

If HMI-controller communication is lost while the LTM R controller is in Local RJ45 control mode, the LTM R controller enters the fallback state. If HMI-LTM R controller communication is lost while the LTM R controller is not in Local RJ45 control mode, and then the control mode is changed to Local RJ45 control, the LTM R controller enters the fallback state.

If HMI-controller communication is restored while the control mode is set to Local RJ45 control, the IMPR exits from the fallback state. If the control mode is changed to Local Terminal Strip or Network control, the IMPR exits from the fallback state, regardless of the state of HMI-controller communications.

The table below defines the available actions that the LTM R controller may take during a communication loss. Select one of these actions when configuring the LTM R controller.

Local RJ45 Communication Loss Actions:

LTM R controller output control mode prior to network loss	**Available LTM R controller actions after HMI - LTM R controller network loss**
Local Terminal Strip	Fault and Warning control possibilities: - Signal nothing - Activate a warning - Activate a fault - Activate a fault and warning
Local RJ45	Fault and Warning control possibilities: - Signal nothing - Activate a warning - Activate a fault - Activate a fault and warning
Remote	Fault and Warning control possibilities: - Signal nothing - Activate a warning - Activate a fault - Activate a fault and warning - The behavior of the LO1 and LO2 relays depends on the motor controller mode and on the fallback strategy chosen

Note: For information about a communication loss and the fallback strategy to follow, see *p. 105*.

Appendices

Wiring Diagrams

Overview

The LTM R operating mode wiring diagrams can be drawn according to 2 standards:

- IEC
- NEMA.

What's in this Appendix?

The appendix contains the following chapters:

Chapter	Chapter Name	Page
A	IEC Format Wiring Diagrams	511
B	NEMA Format Wiring Diagrams	531

IEC Format Wiring Diagrams

A

IEC Wiring Diagrams

Overview

This section contains the wiring diagrams corresponding to the 5 pre-configured operating modes:

Overload	Monitoring of the motor load where control (start/stop) of the motor load is achieved by a mechanism other than the controller
Independent	Direct-on-line (across-the-line) full-voltage non-reversing motor starting applications
Reverser	Direct-on-line (across-the-line) full-voltage reversing motor starting applications
Two-Step	Reduced voltage starting motor applications, including: • Wye-Delta • Open Transition Primary Resistor • Open Transition Autotransformer
Two-Speed	Two-speed motor applications for motor types, including: • Dahlander (consequent pole) • Pole Changer

Each application is described individually, with:

1 complete application diagram (including power and control)	3-wire (impulse) local control
3 partial diagrams (control logic input wiring variants)	2-wire (maintained) local control
	3-wire (impulse) local control with network control selectable
	2-wire (maintained) local control with network control selectable

What's in this Chapter?

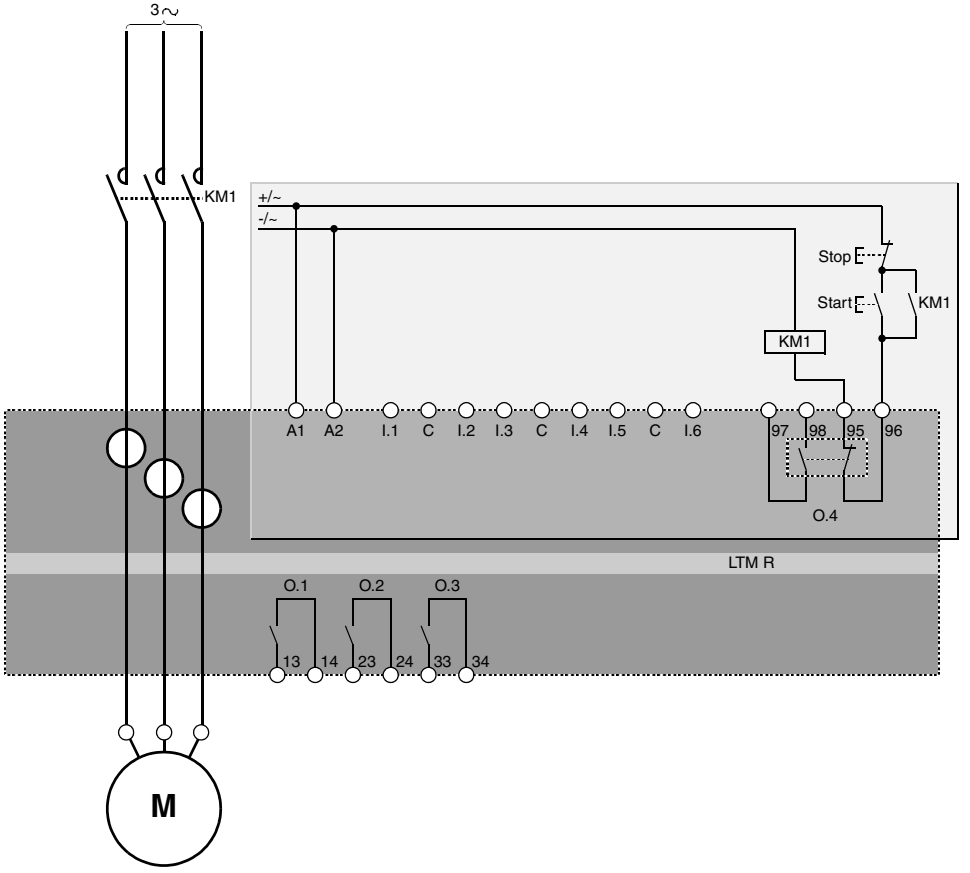
This chapter contains the following topics:

Topic	Page
Overload Mode Wiring Diagrams	513
Independent Mode Wiring Diagrams	517
Reverser Mode Wiring Diagrams	519
Two-Step Wye-Delta Mode Wiring Diagrams	521
Two-Step Primary Resistor Mode Wiring Diagrams	523
Two-Step Autotransformer Mode Wiring Diagrams	525
Two-Speed Dahlander Mode Wiring Diagrams	527
Two-Speed Pole Changing Mode Wiring Diagrams	529

Overload Mode Wiring Diagrams

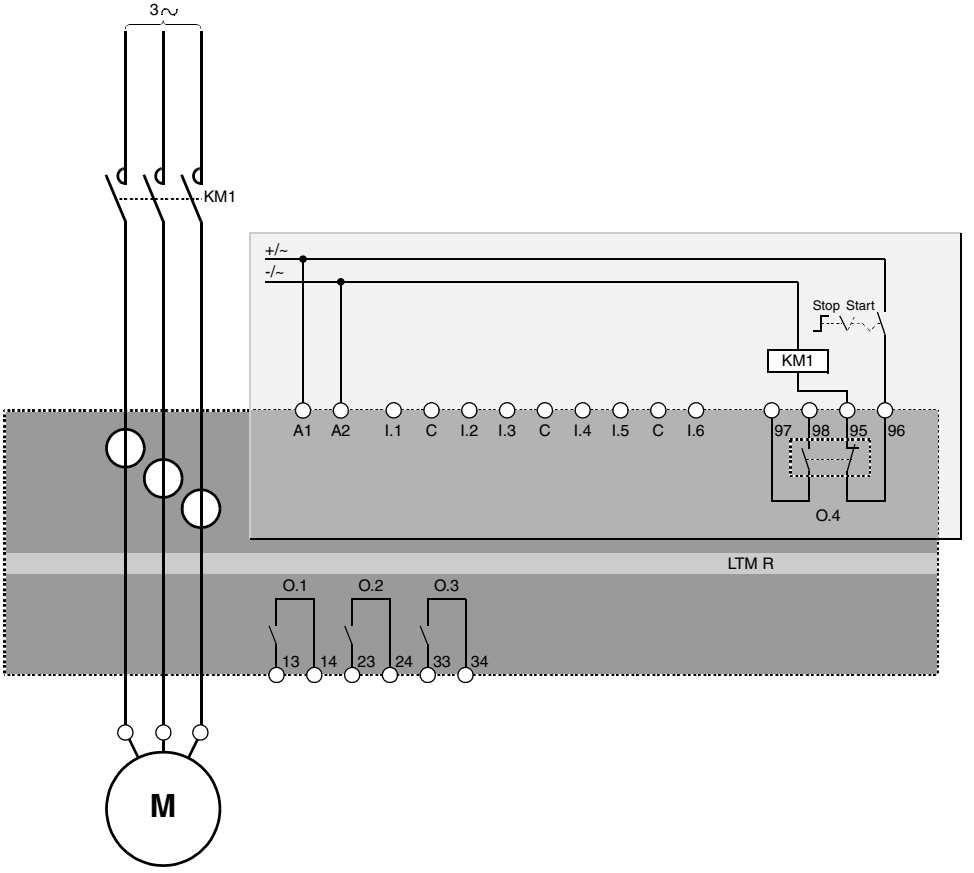
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



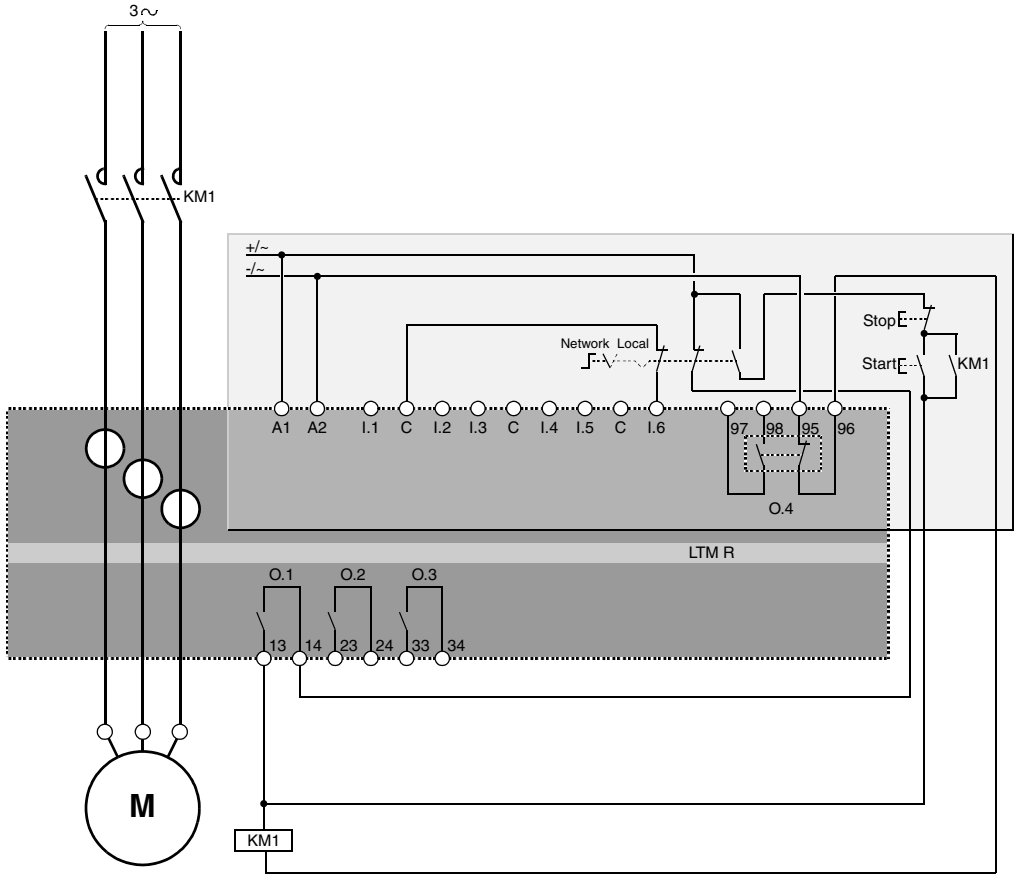
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



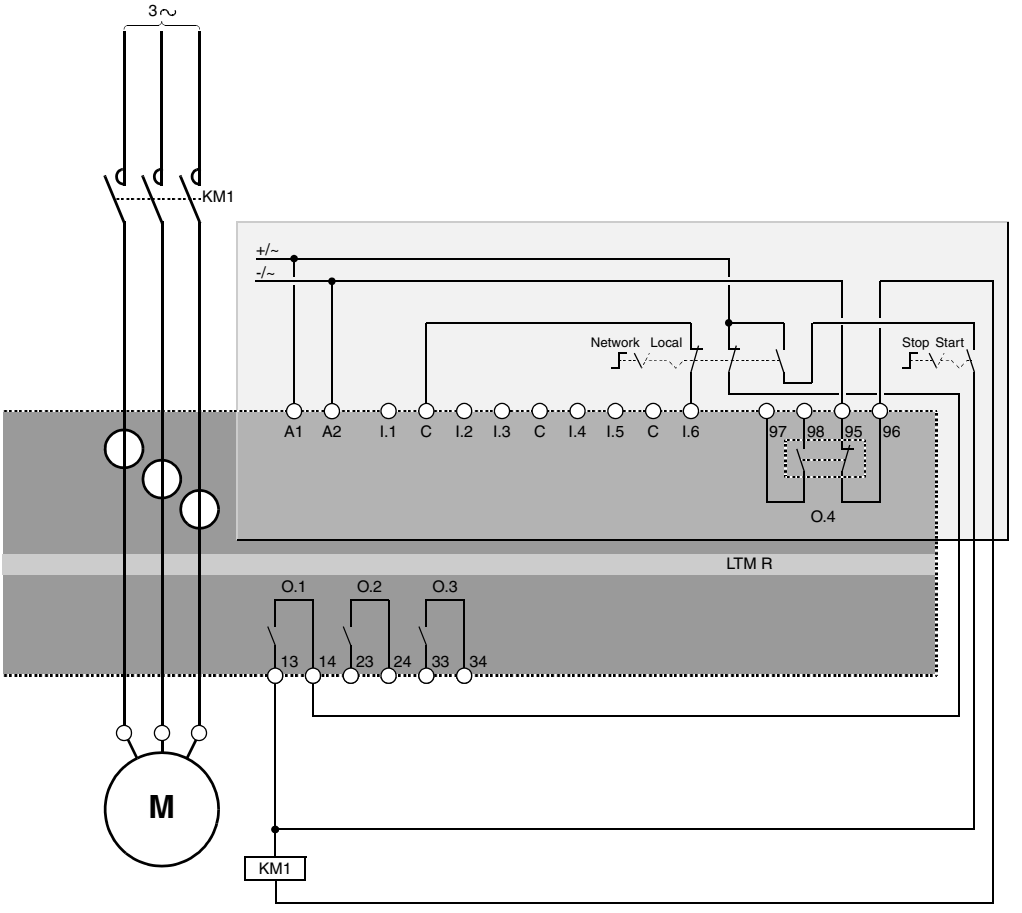
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

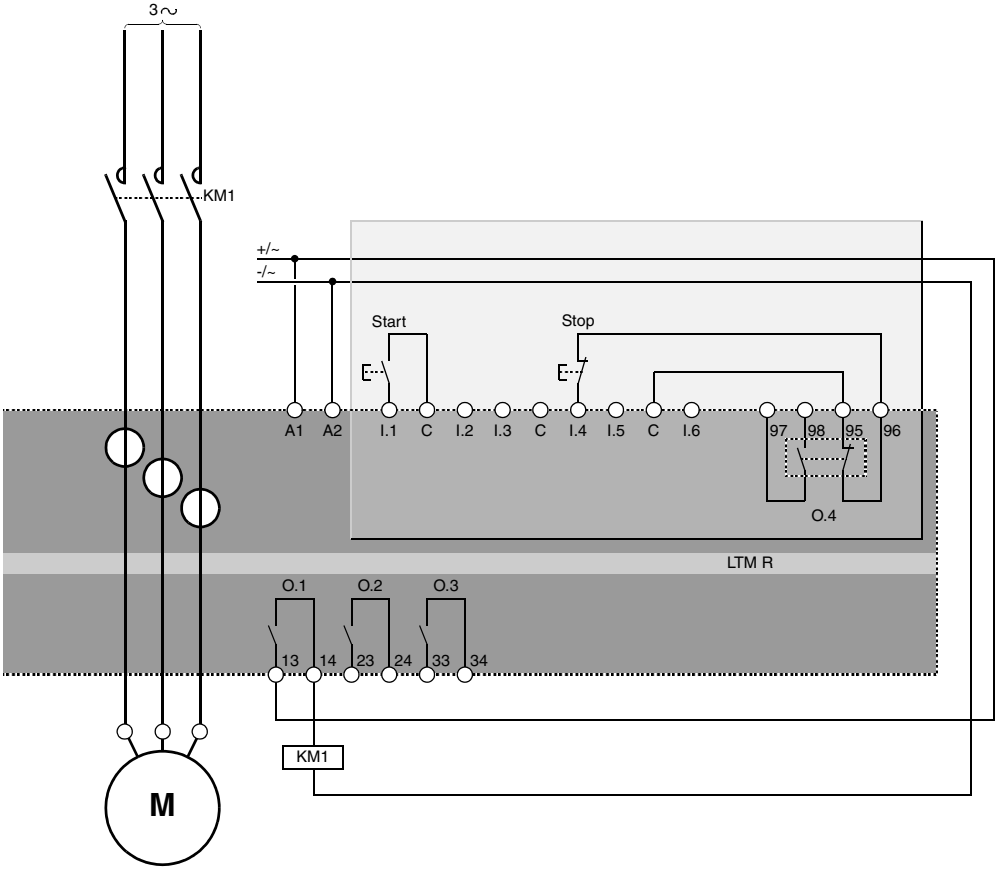
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Independent Mode Wiring Diagrams

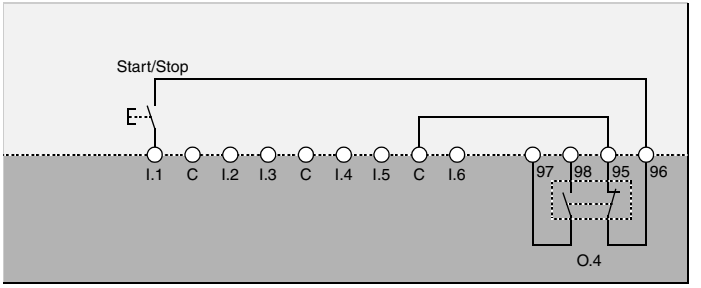
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



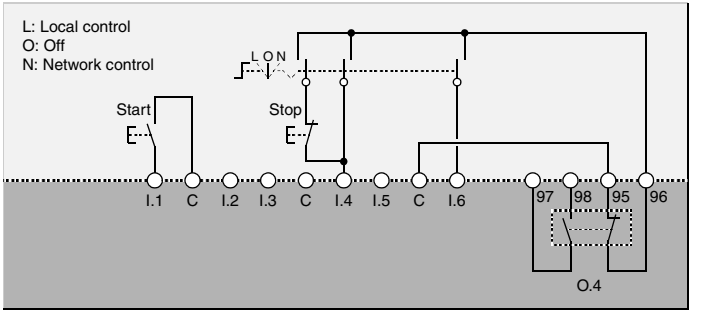
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



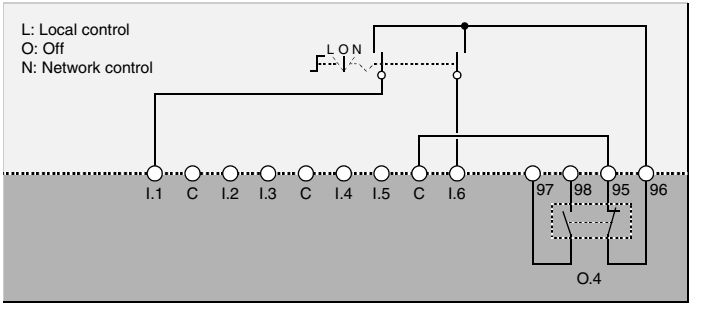
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

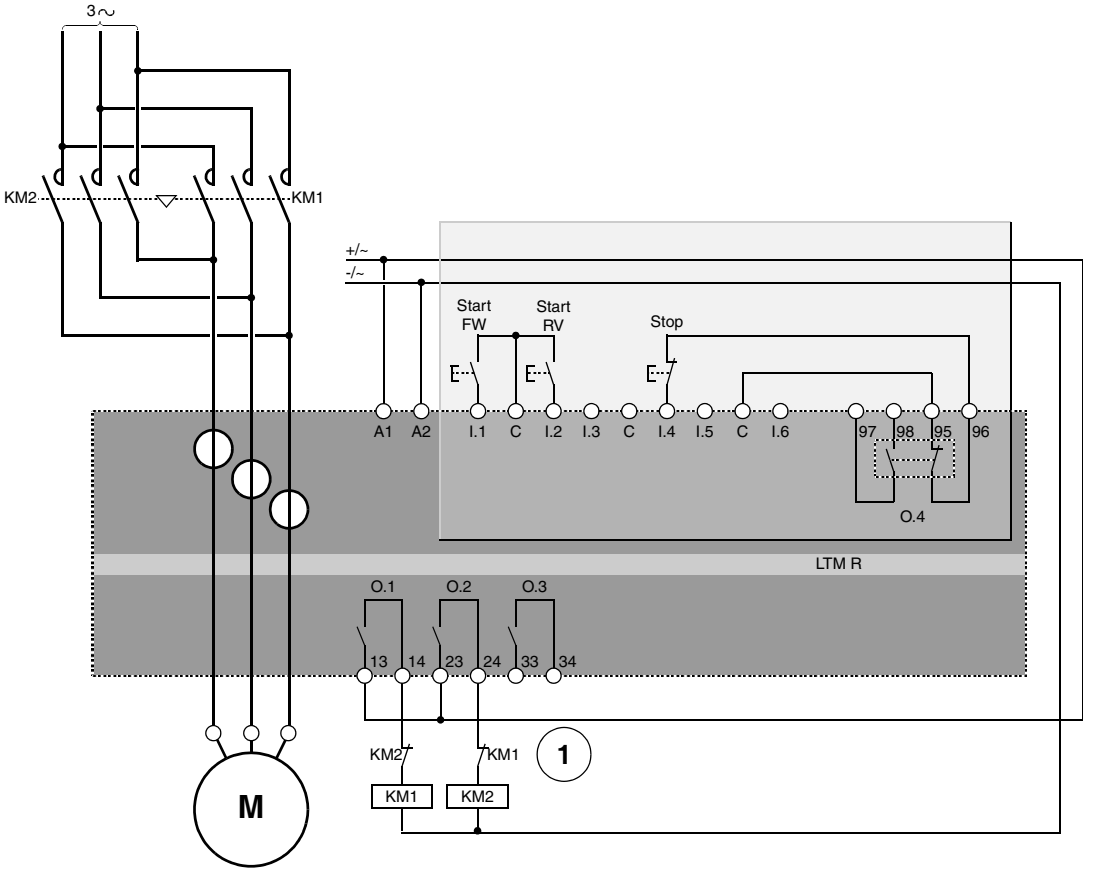
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Reverser Mode Wiring Diagrams

Application Diagram with 3-Wire (Impulse) Local Control

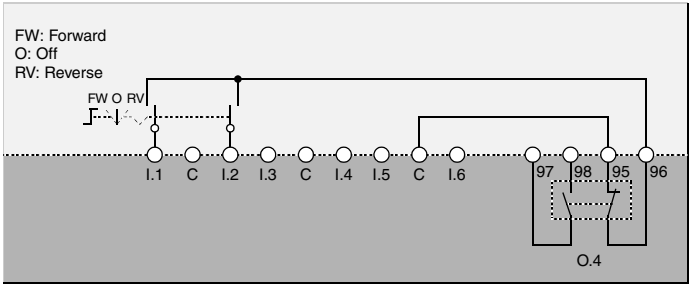
The following application diagram features a 3-wire (impulse) local control wiring diagram:



1 The N.C. interlock contacts KM1 and KM2 are not mandatory because the controller electronically interlocks O.1 and O.2.

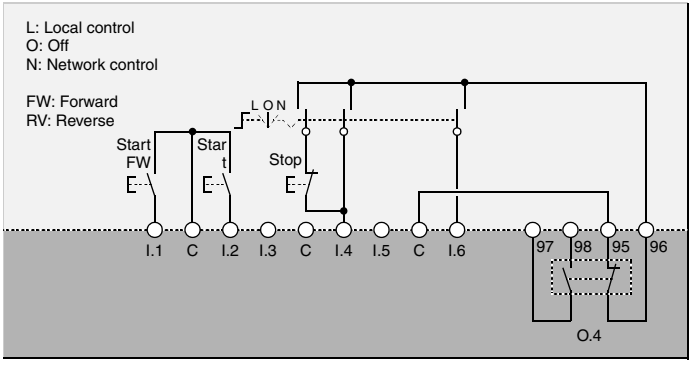
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



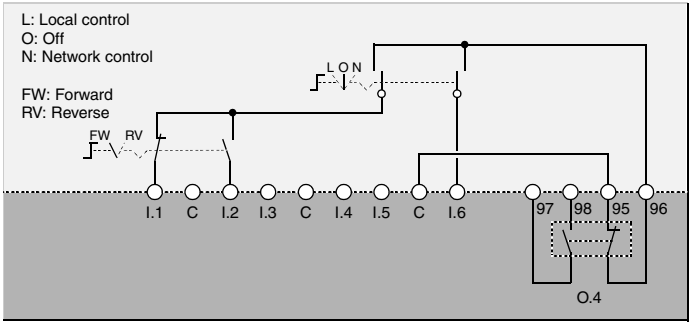
Application Diagram with 3-Wire (Impulse) Local Control with Network Control selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control selectable

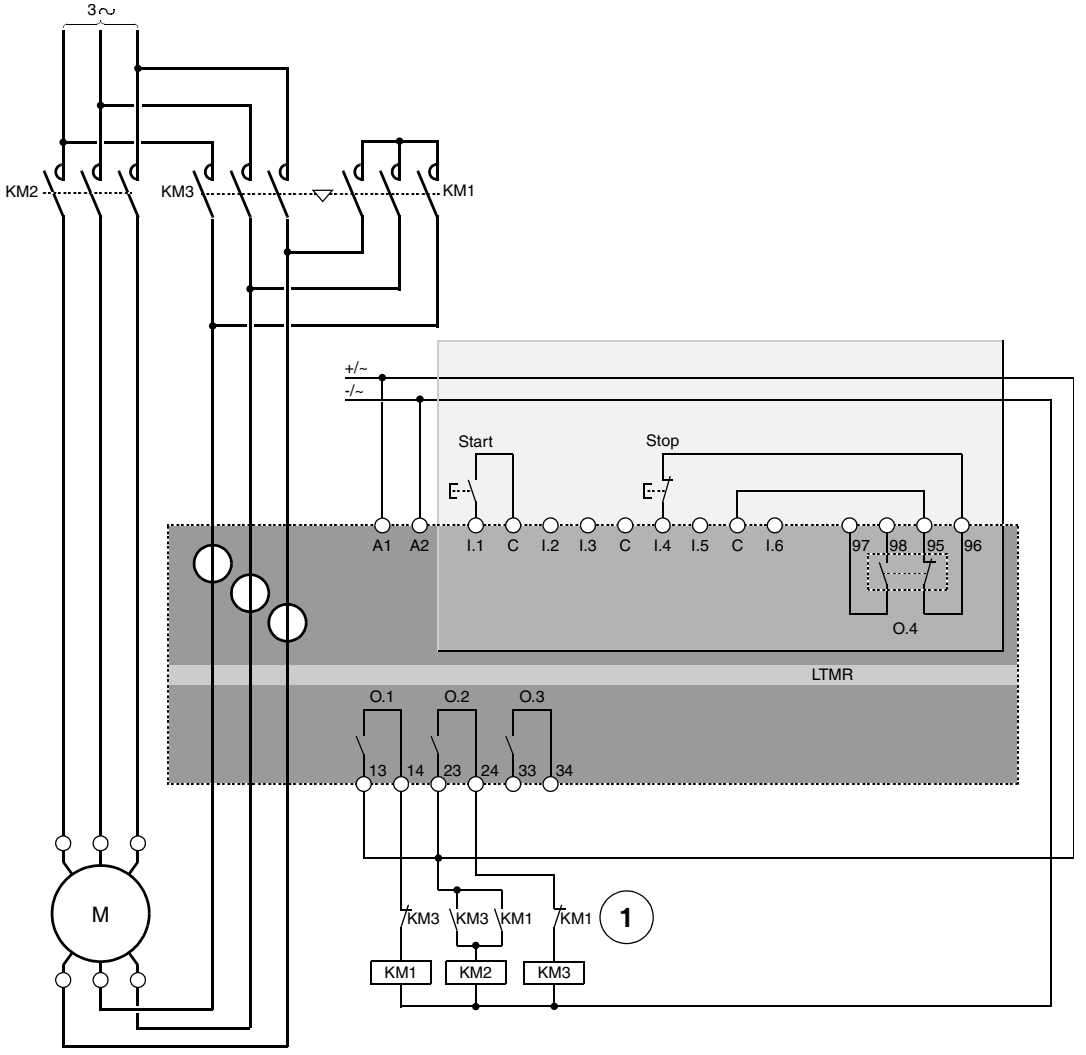
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Step Wye-Delta Mode Wiring Diagrams

Application Diagram with 3-Wire (Impulse) Local Control

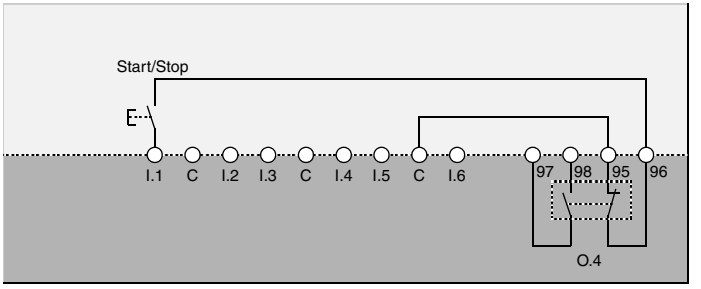
The following application diagram features a 3-wire (impulse) local control wiring diagram:



1 The N.C. interlock contacts KM1 and KM3 are not mandatory because the controller electronically interlocks O.1 and O.2.

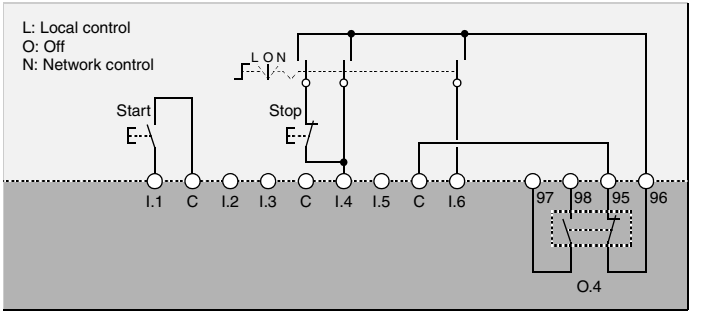
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



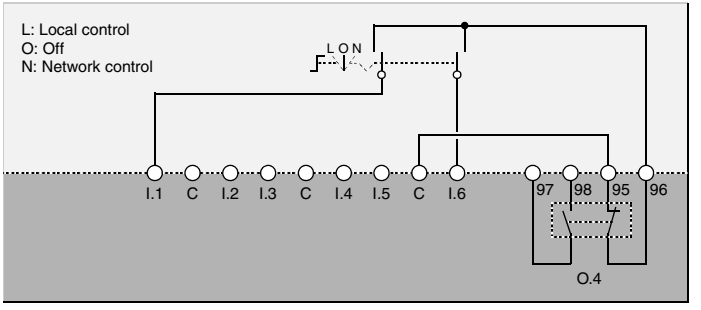
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

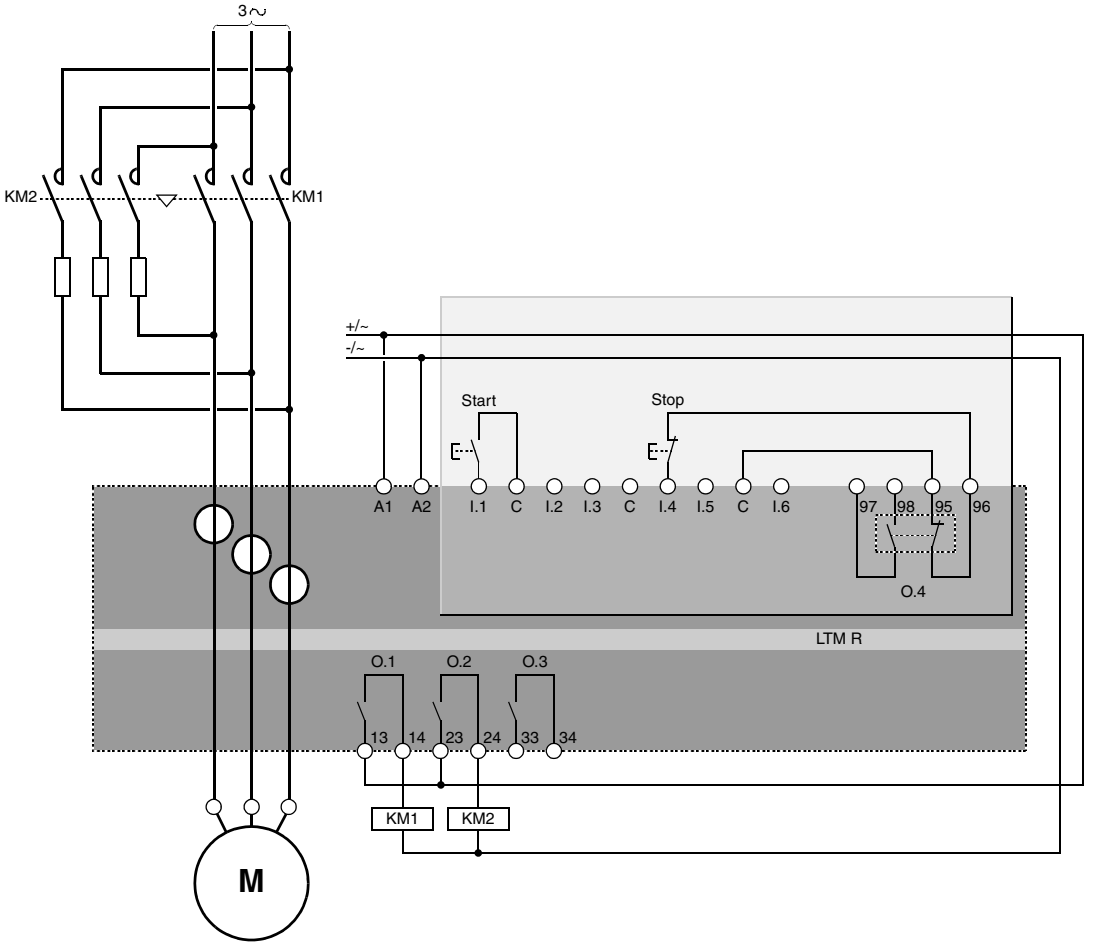
The following application diagram features 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Step Primary Resistor Mode Wiring Diagrams

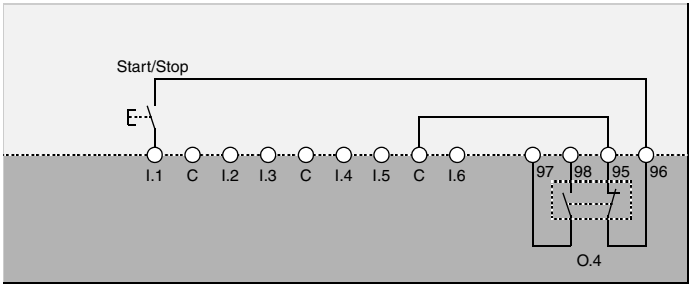
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



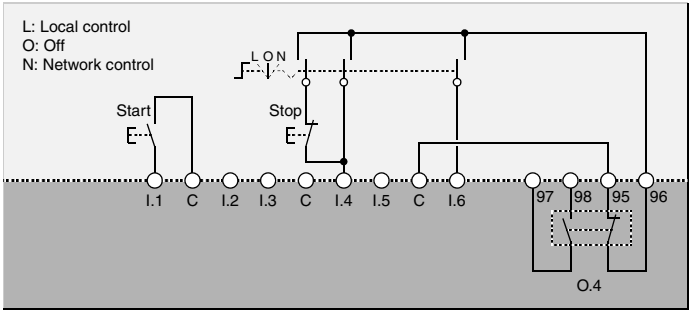
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



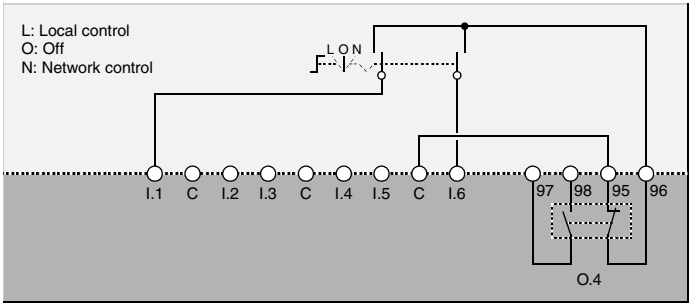
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

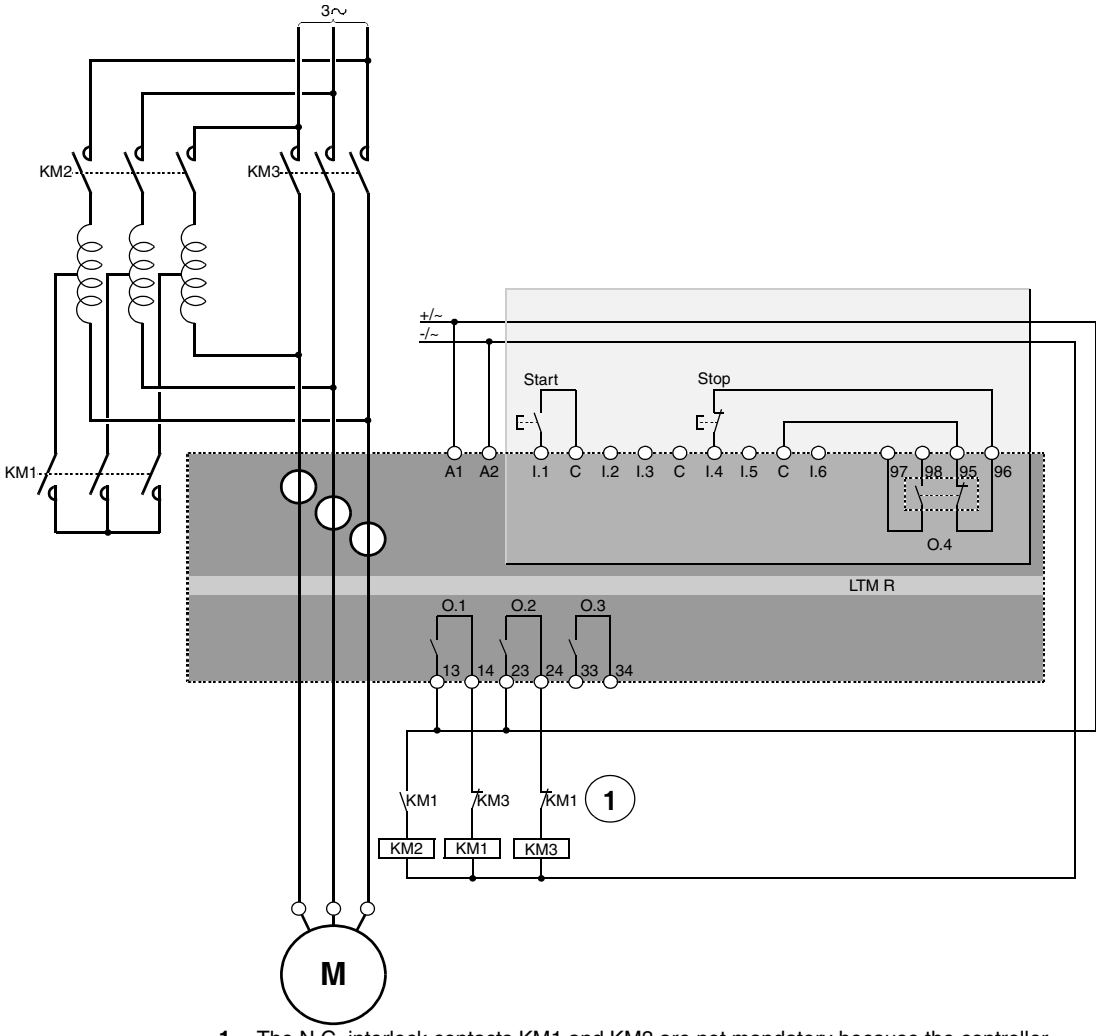
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Step Autotransformer Mode Wiring Diagrams

Application Diagram with 3-Wire (Impulse) Local Control

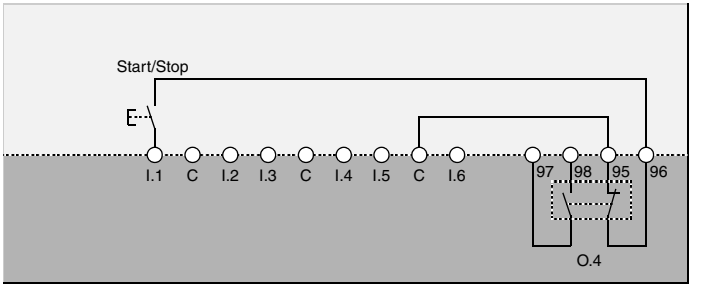
The following application diagram features a 3-wire (impulse) local control wiring diagram:



1 The N.C. interlock contacts KM1 and KM3 are not mandatory because the controller electronically interlocks O.1 and O.2.

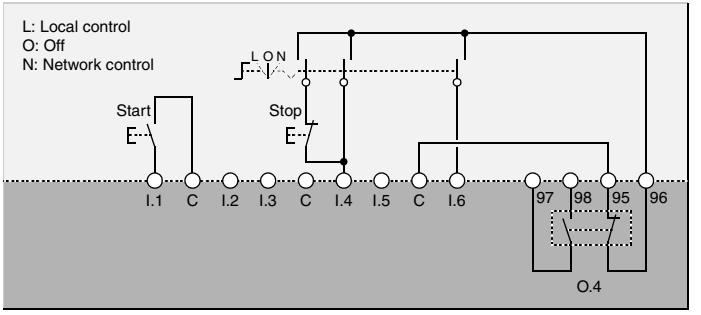
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



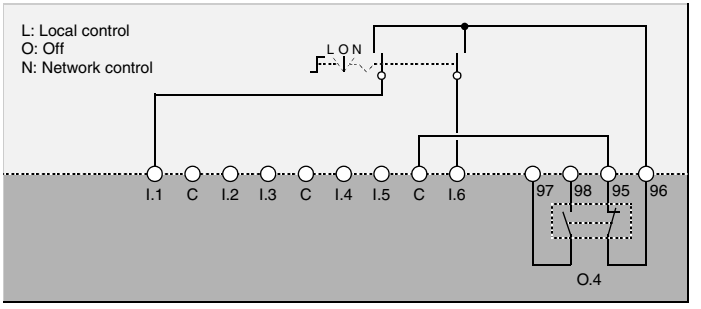
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

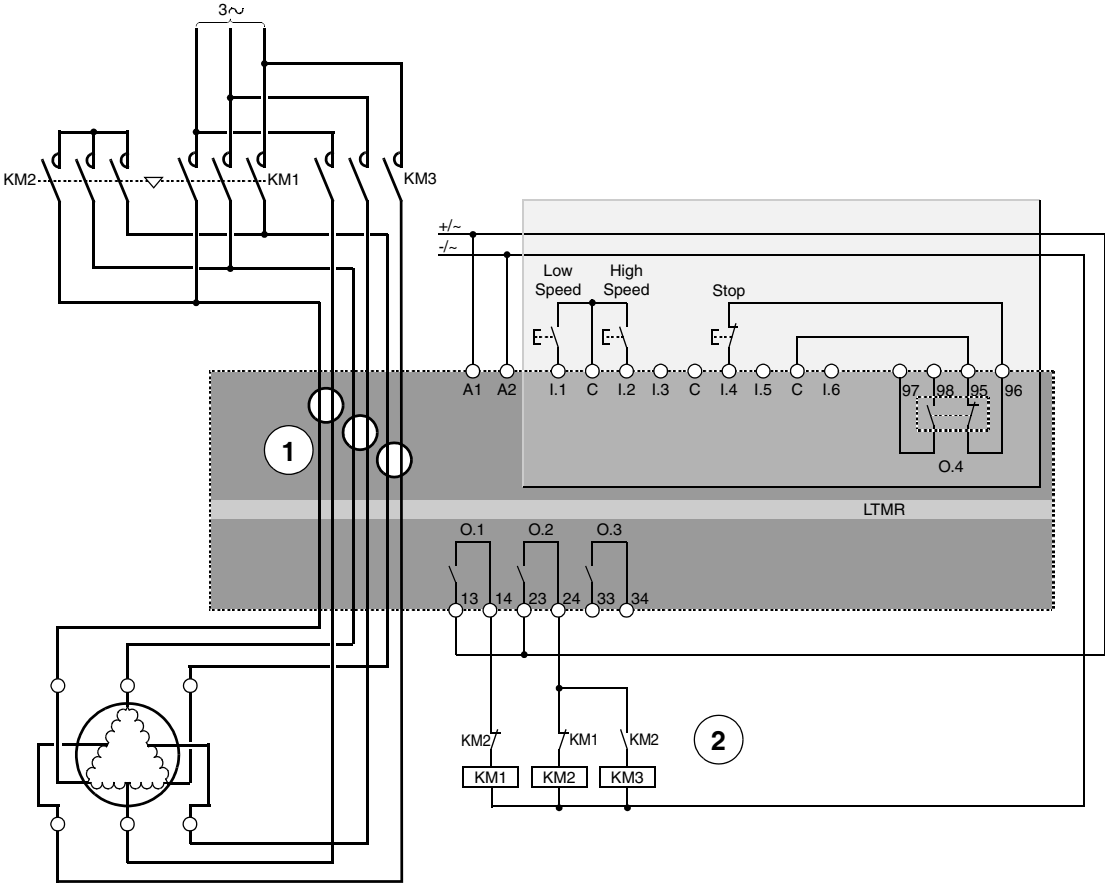
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Speed Dahlander Mode Wiring Diagrams

Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:

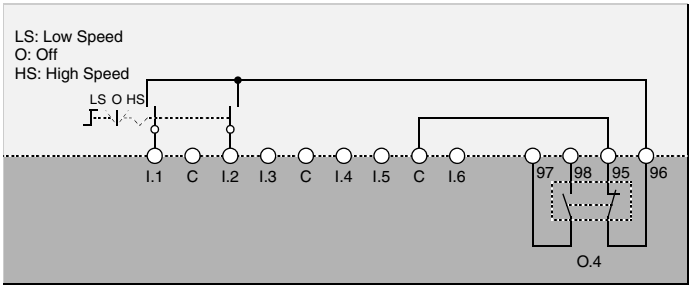


1 A Dahlander application requires 2 sets of wires passing through the CT windows. The controller can also be placed upstream of the contactors. If this is the case, and if the Dahlander motor is used in variable torque mode, all the wires downstream of the contactors must be the same size.

2 The N.C. interlock contacts KM1 and KM2 are not mandatory because the controller electronically interlocks O.1 and O.2.

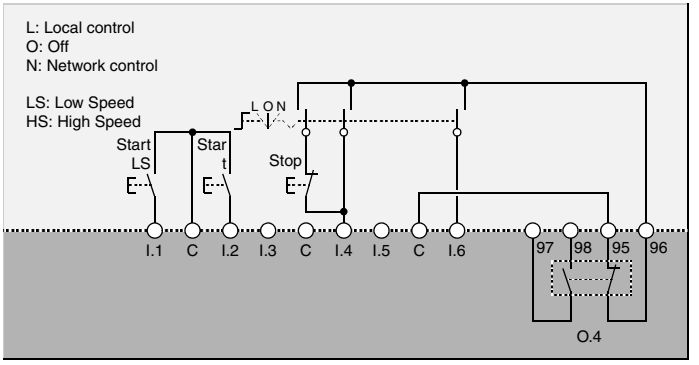
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



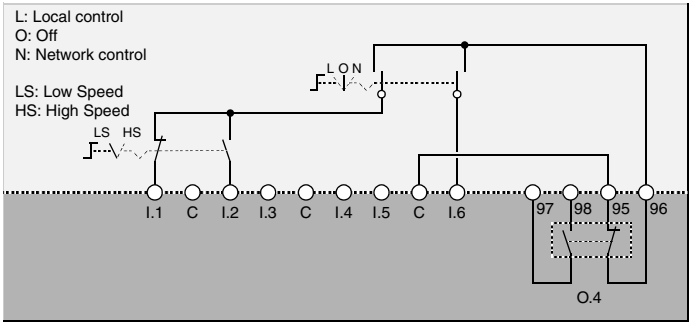
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

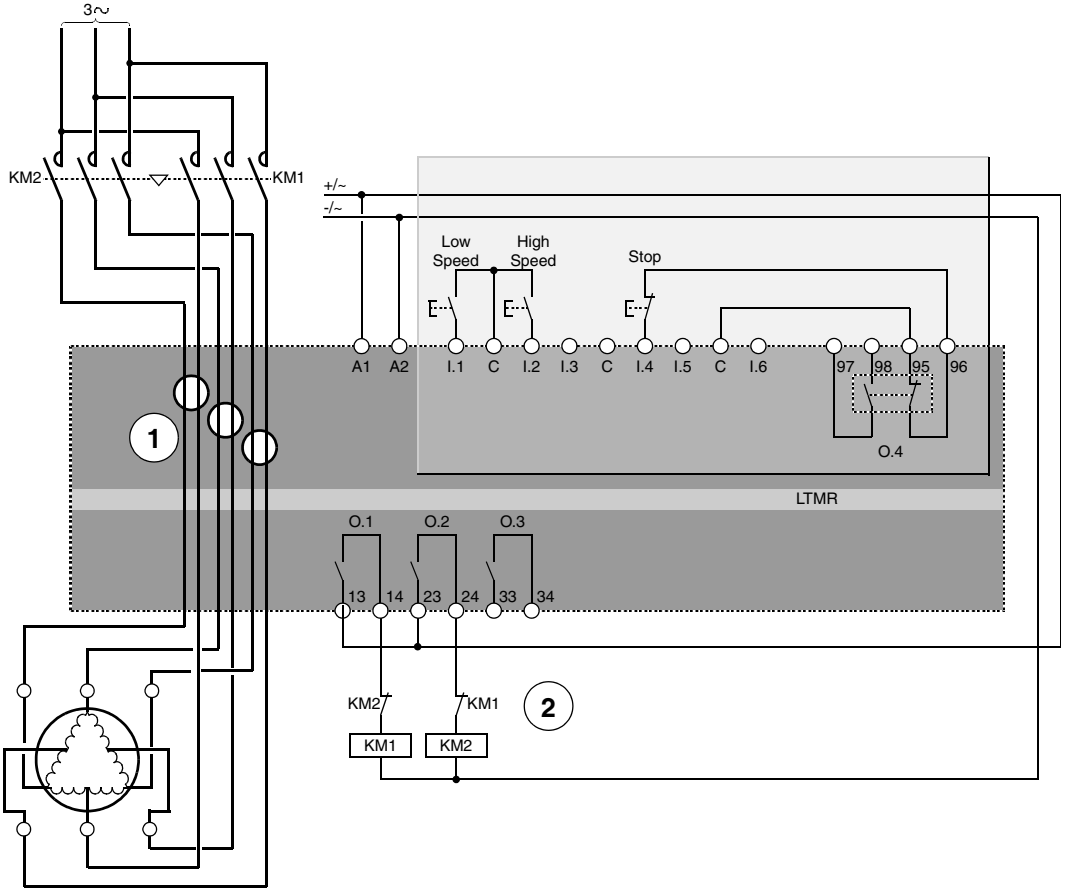
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Speed Pole Changing Mode Wiring Diagrams

Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:

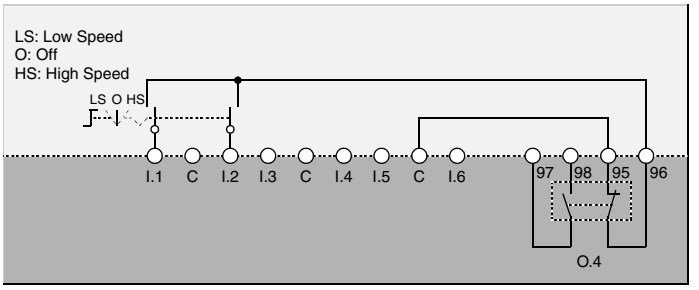


1 A pole-changing application requires two sets of wires passing through the CT windows. The controller can also be placed upstream of the contactors. If this is the case, all the wires downstream of the contactors must be the same size.

2 The N.C. interlock contacts KM1 and KM2 are not mandatory because the controller firmware interlocks O.1 and O.2.

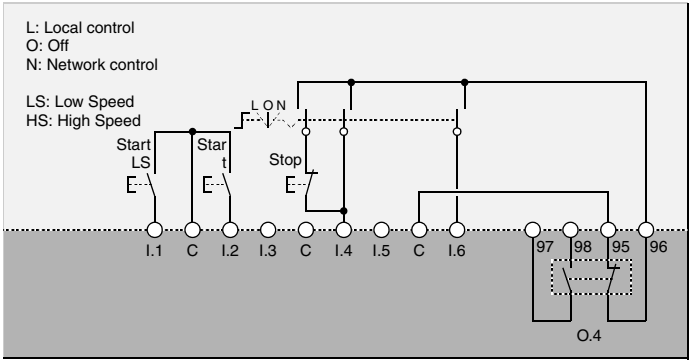
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



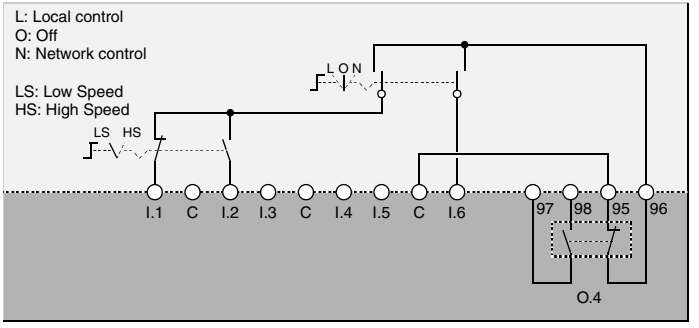
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local control with Network Control Selectable

The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



NEMA Format Wiring Diagrams

B

NEMA Wiring Diagrams

Overview

This section contains the wiring diagrams corresponding to the 5 pre-configured operating modes:

Overload	Monitoring of the motor load where control (start/stop) of the motor load is achieved by a mechanism other than the controller
Independent	Direct-on-line (across-the-line) full-voltage non-reversing motor starting applications
Reverser	Direct-on-line (across-the-line) full-voltage reversing motor starting applications
Two-Step	Reduced voltage starting motor applications, including: • Wye-Delta • Open Transition Primary Resistor • Open Transition Autotransformer
Two-Speed	Two-speed motor applications for motor types, including: • Single winding (consequent pole) • Separate winding

Each application is described individually, with:

1 complete application diagram (including power and control)	3-wire (impulse) local control
3 partial diagrams (control logic input wiring variants)	2-wire (maintained) local control
	3-wire (impulse) local control with network control selectable
	2-wire (maintained) local control with network control selectable

What's in this Chapter?

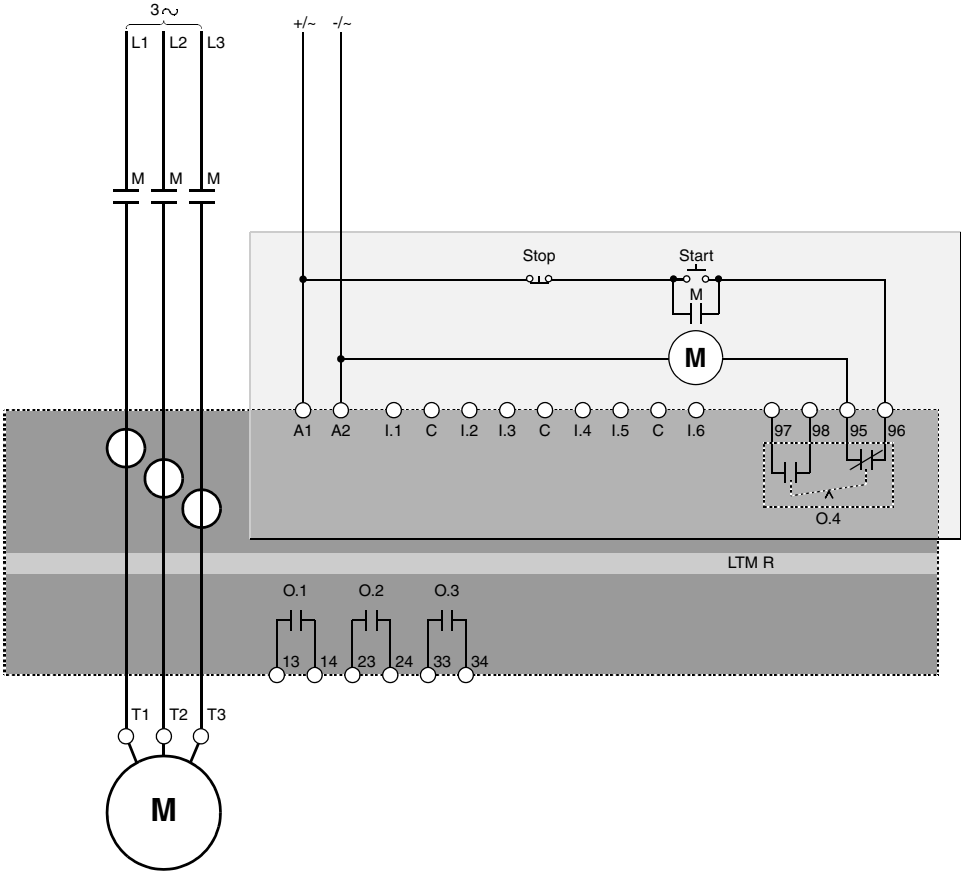
This chapter contains the following topics:

Topic	Page
Overload Mode Wiring Diagrams	533
Independent Mode Wiring Diagrams	537
Reverser Mode Wiring Diagrams	539
Two-Step Wye-Delta Mode Wiring Diagrams	541
Two-Step Primary Resistor Mode Wiring Diagrams	543
Two-Step Autotransformer Mode Wiring Diagrams	545
Two-Speed Mode Wiring Diagrams: Single Winding (Consequent Pole)	547
Two-Speed Mode Wiring Diagrams: Separate Winding	549

Overload Mode Wiring Diagrams

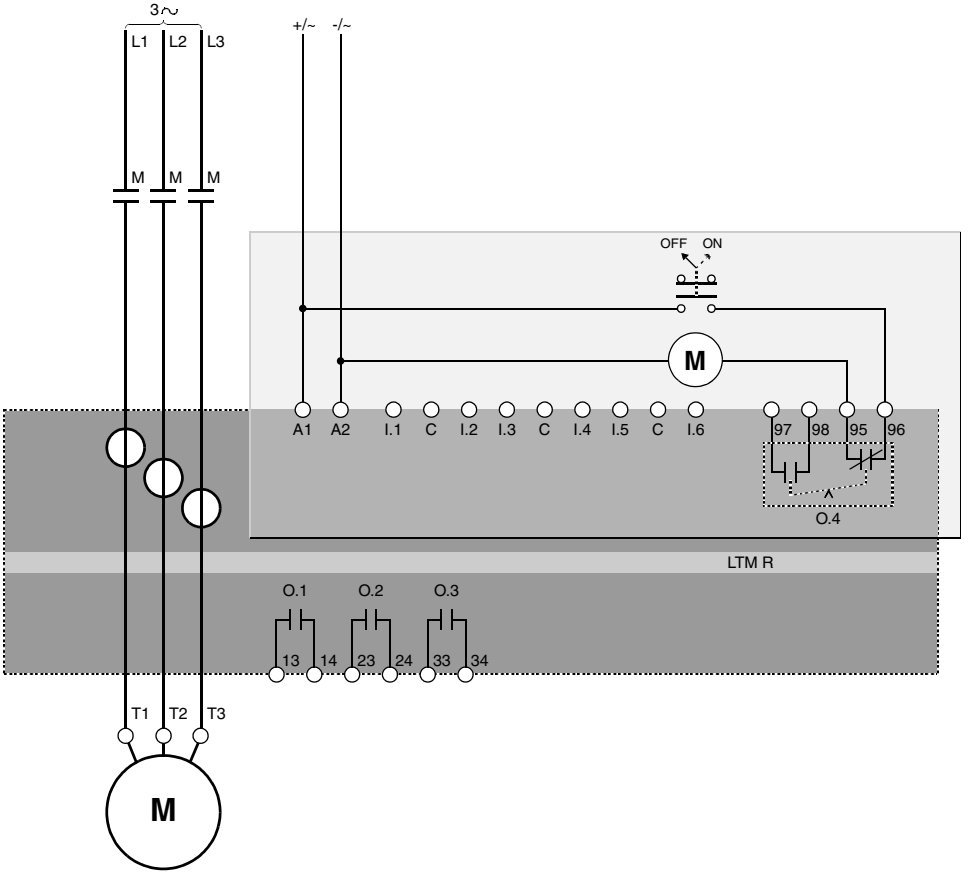
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



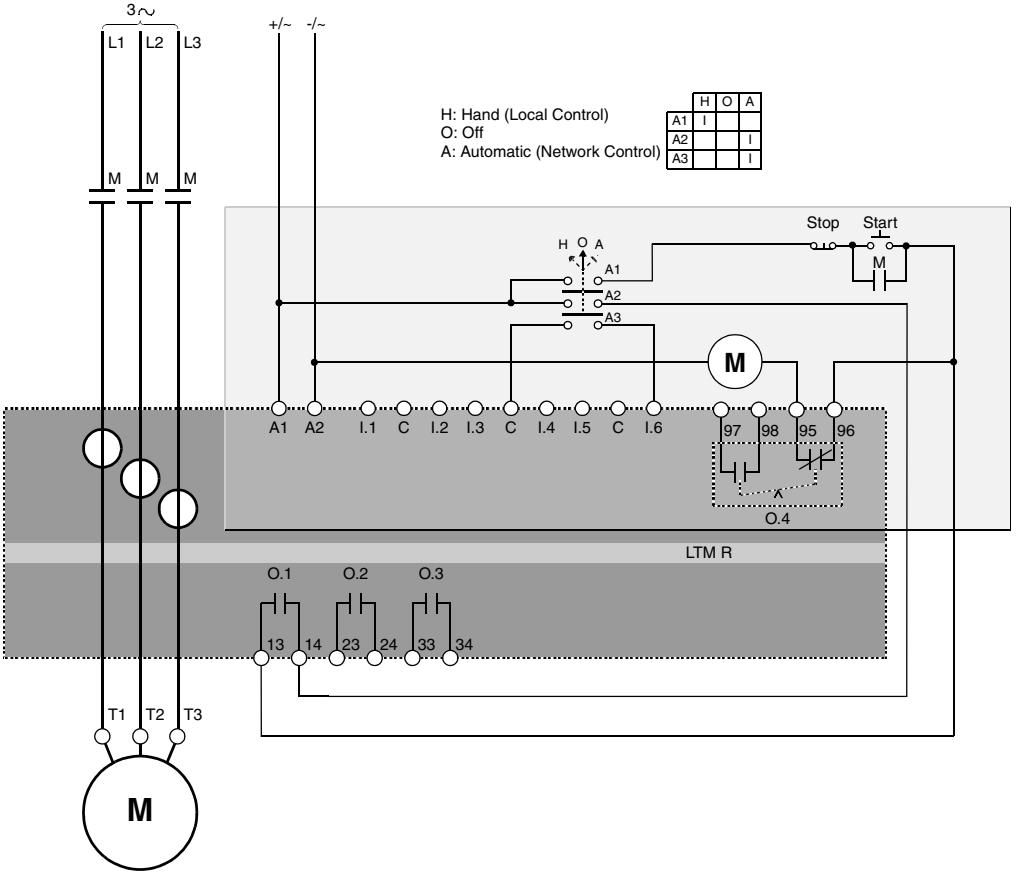
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



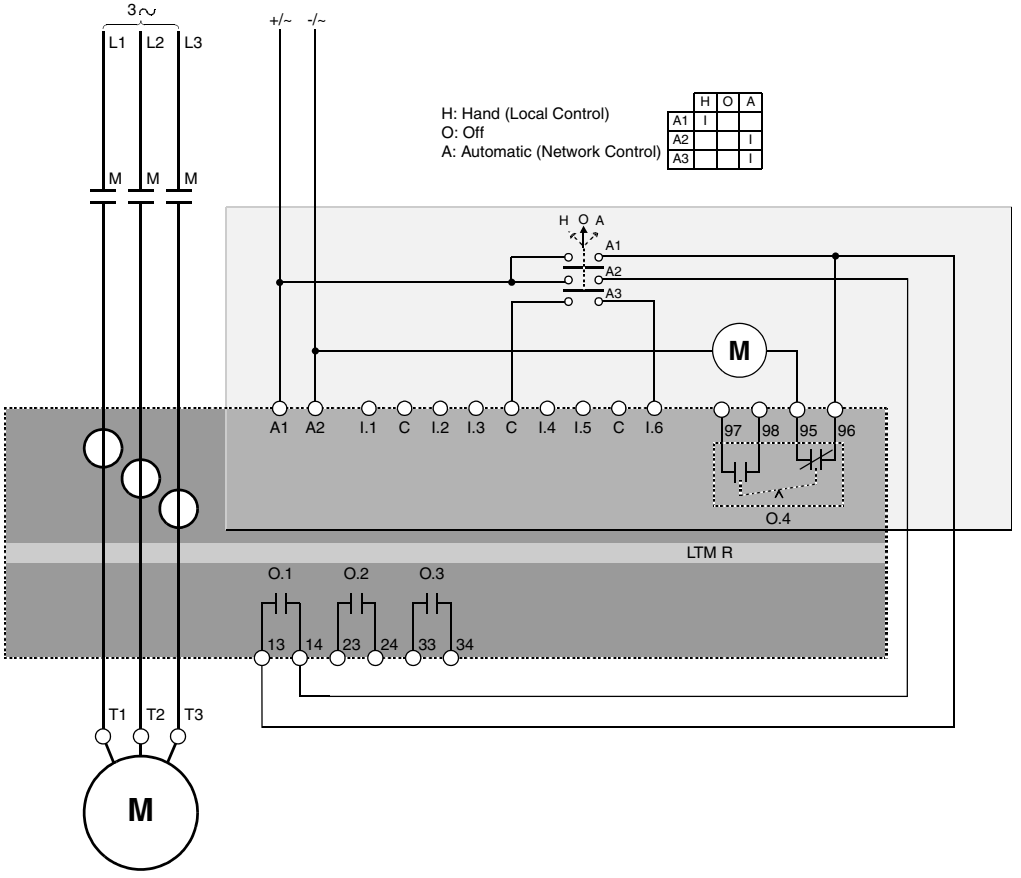
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

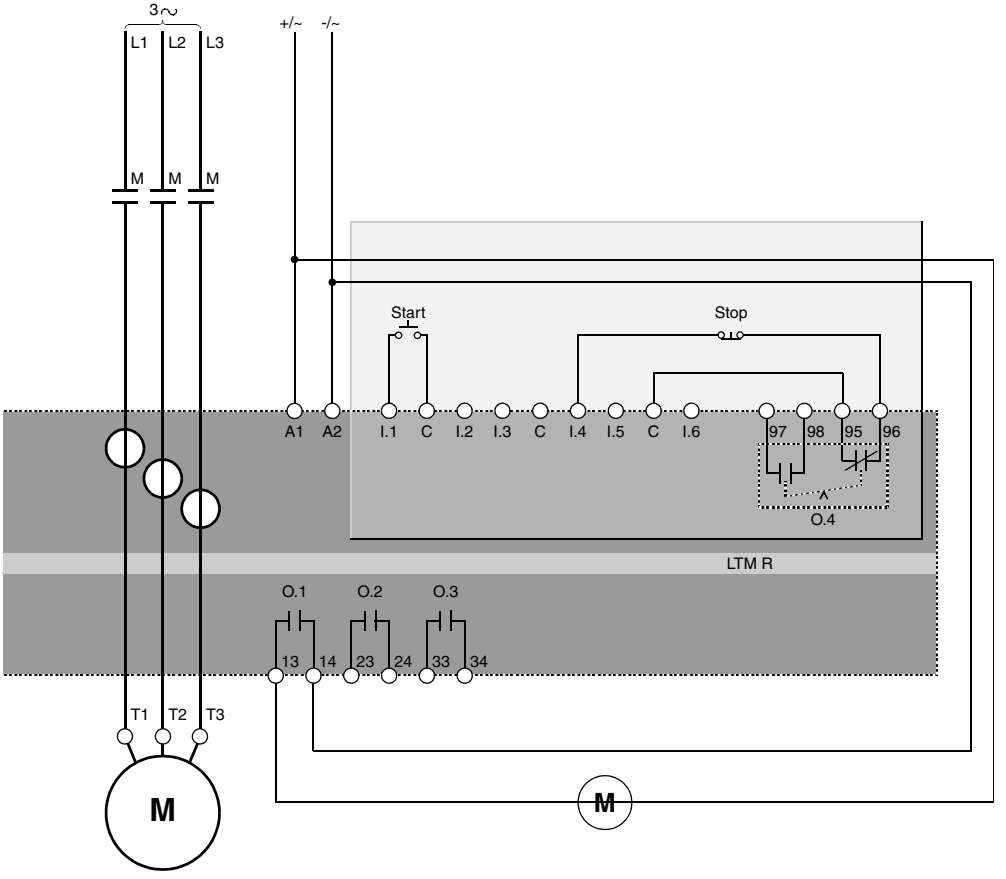
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Independent Mode Wiring Diagrams

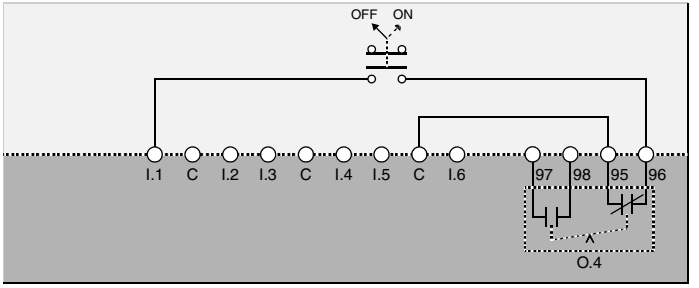
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



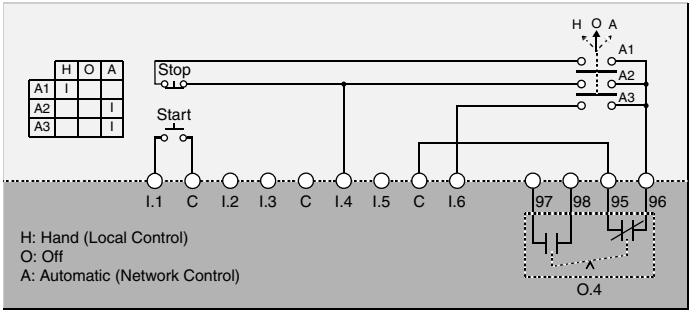
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



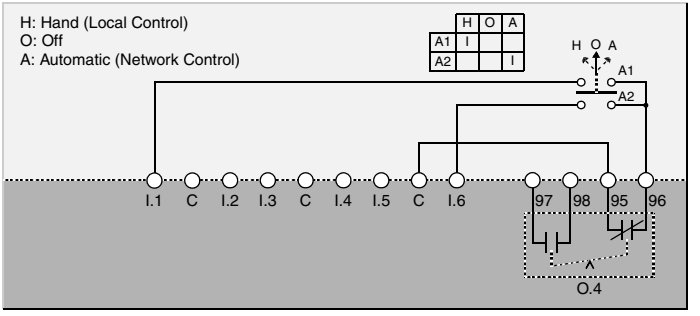
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

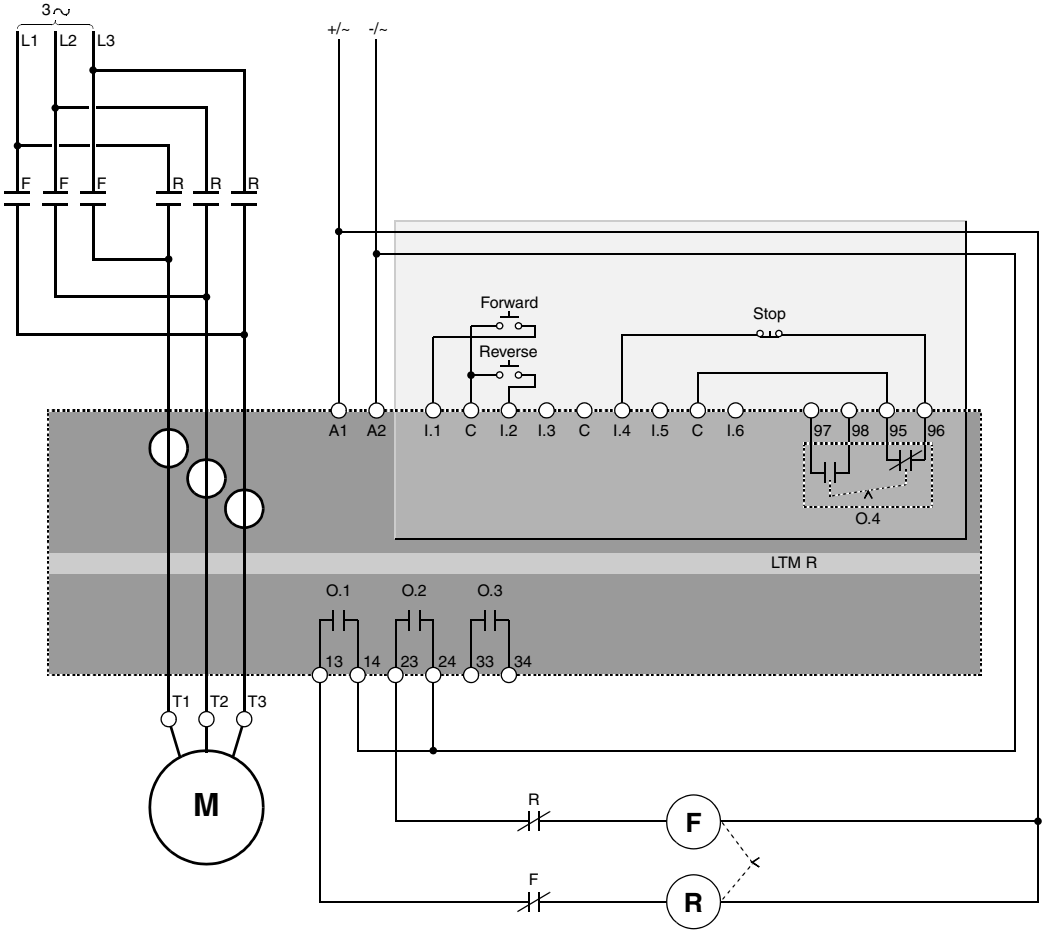
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Reverser Mode Wiring Diagrams

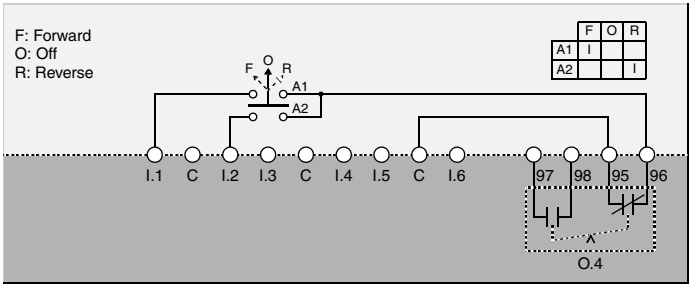
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



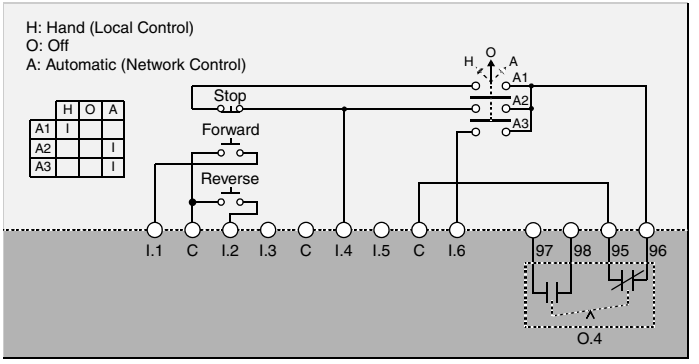
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



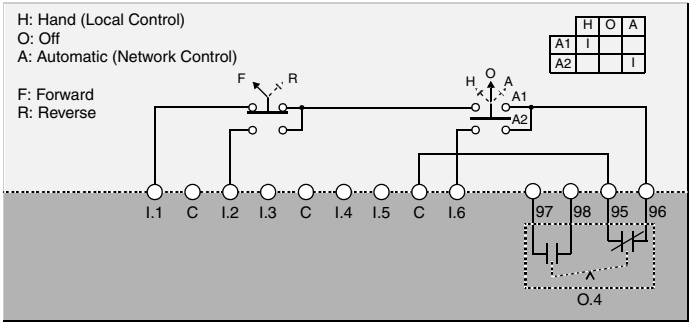
Application Diagram with 3-Wire (Impulse) Local Control with Network control selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network control selectable

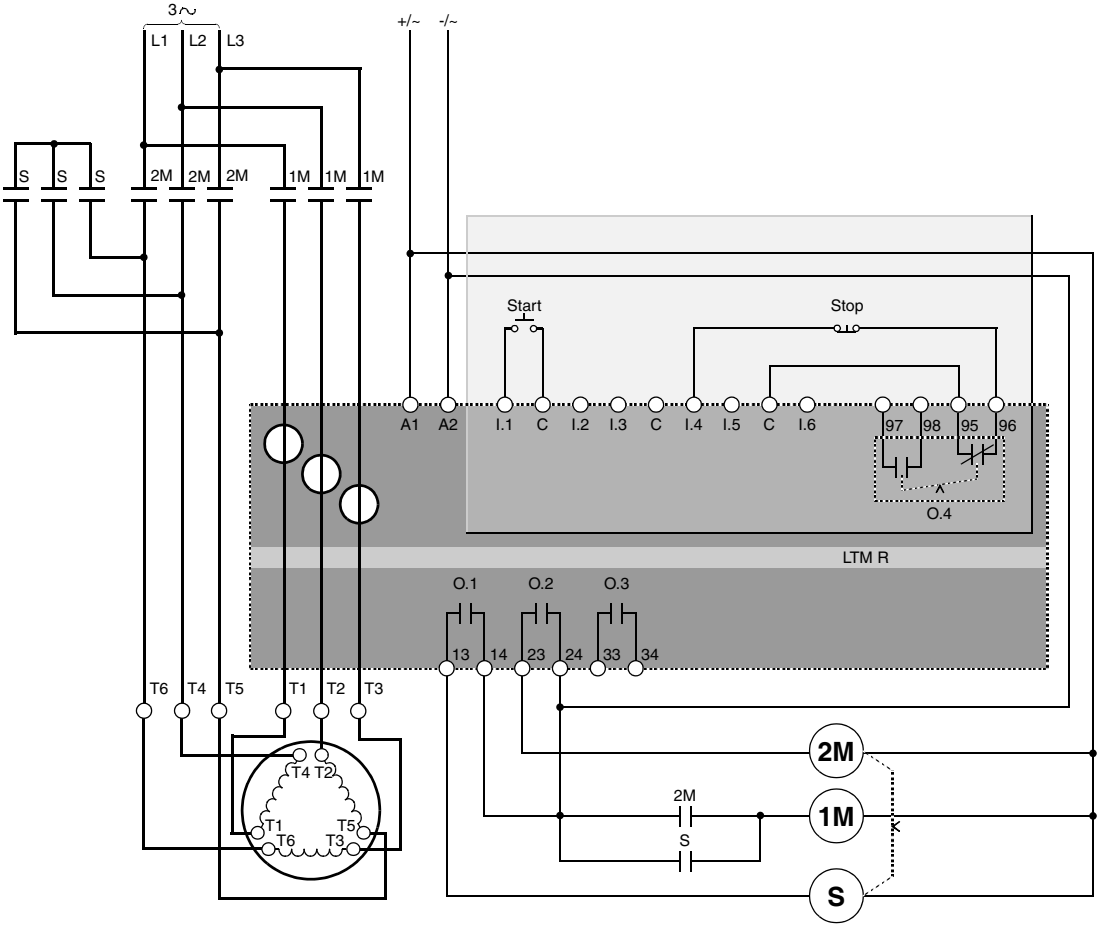
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Step Wye-Delta Mode Wiring Diagrams

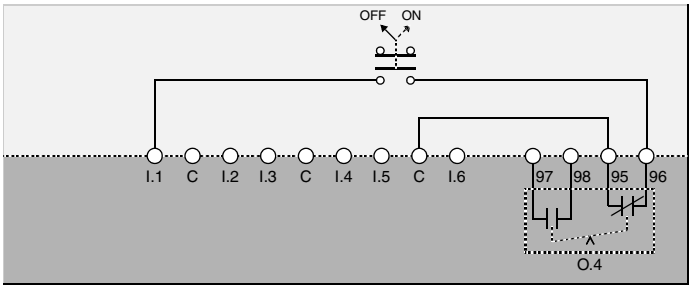
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



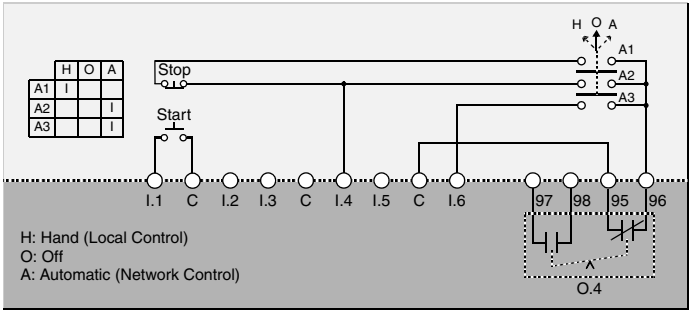
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



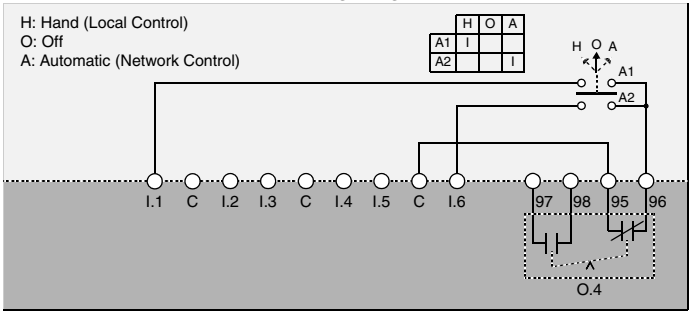
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

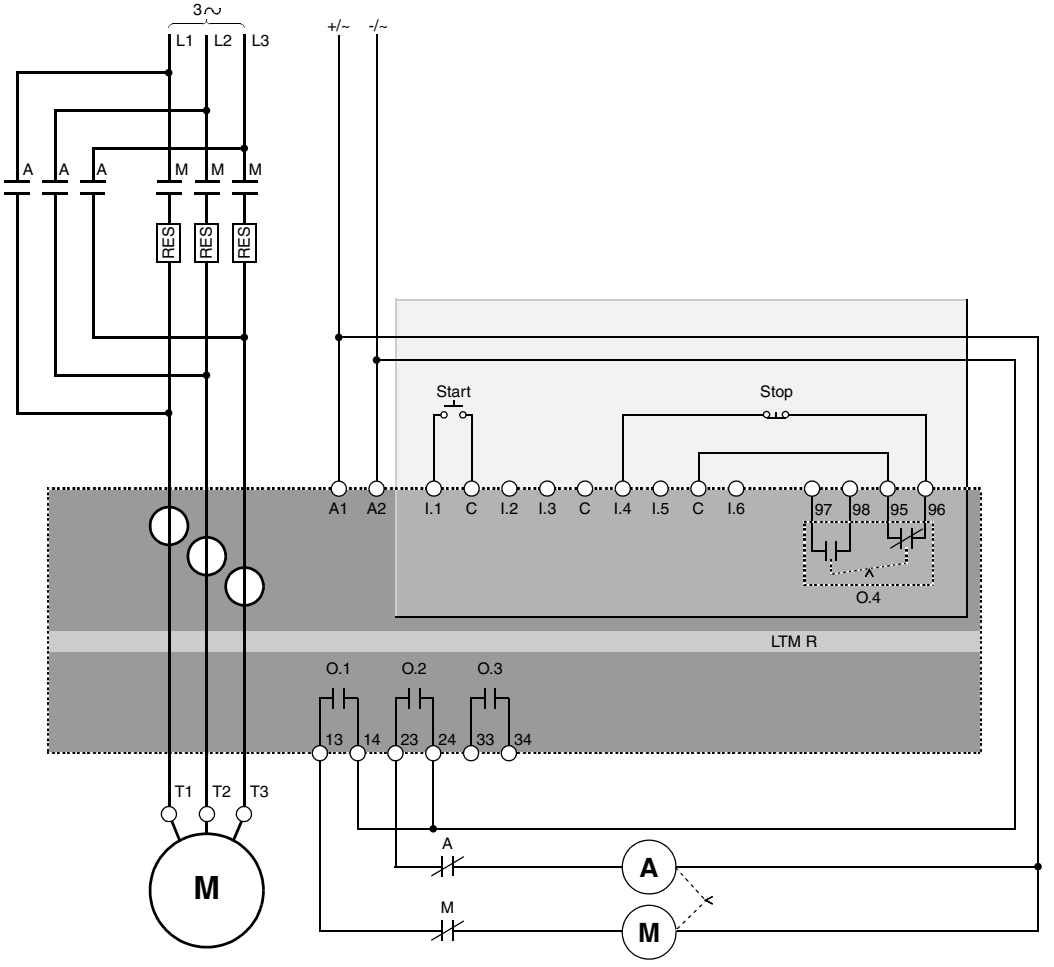
The following application diagram features 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Step Primary Resistor Mode Wiring Diagrams

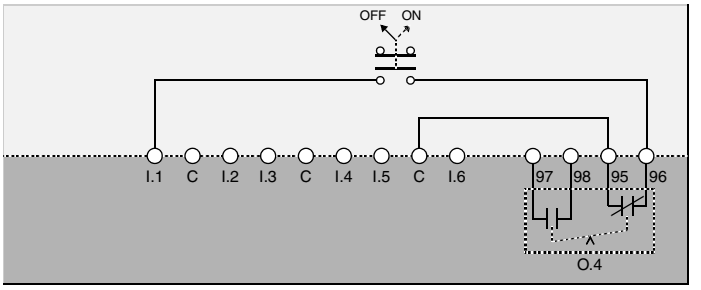
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



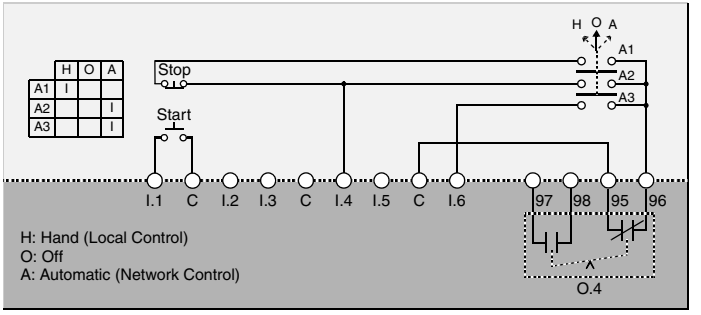
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



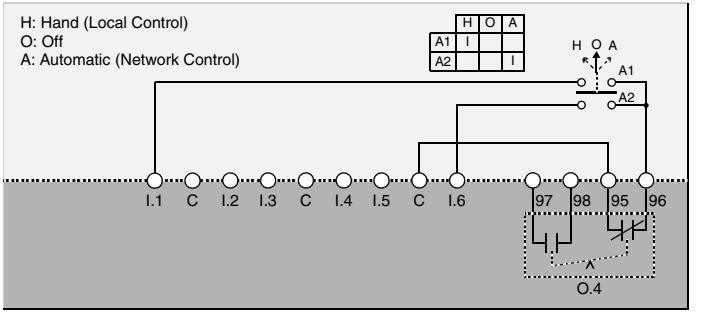
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

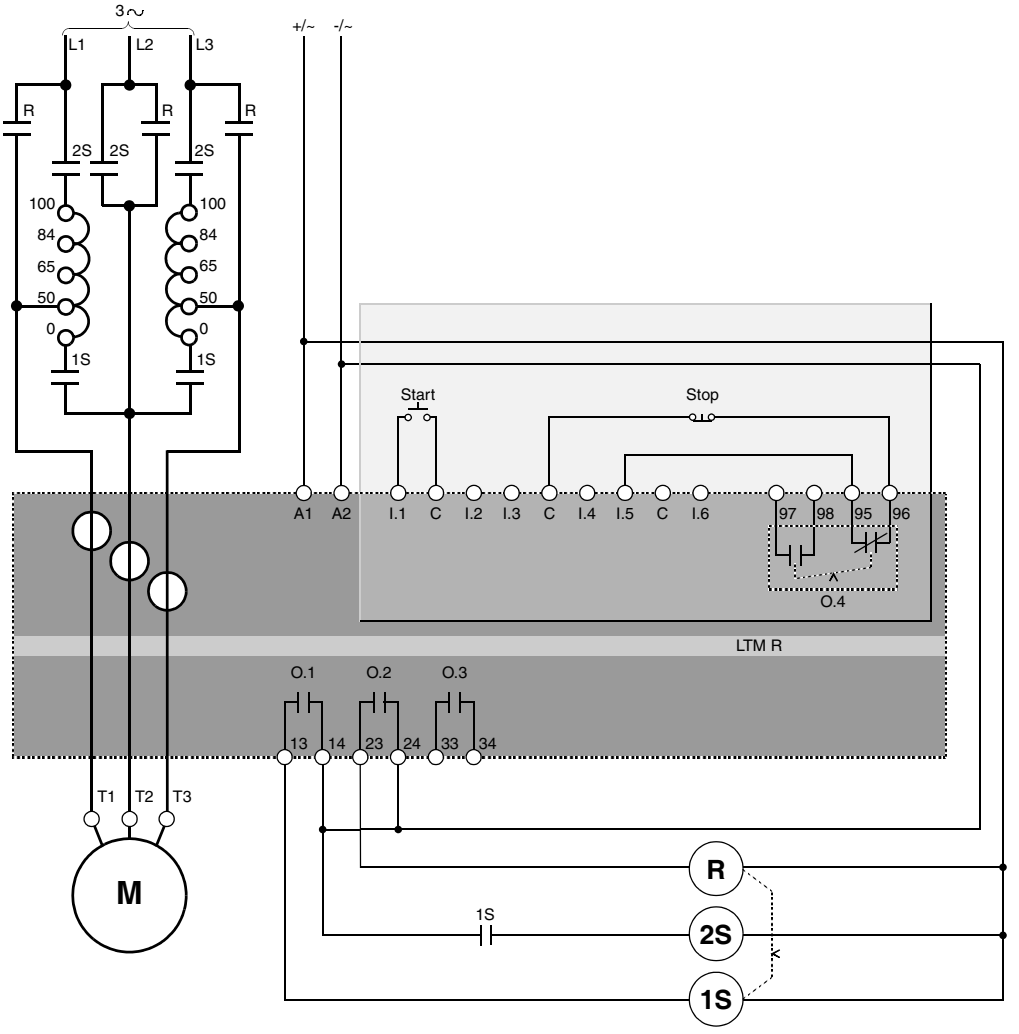
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Step Autotransformer Mode Wiring Diagrams

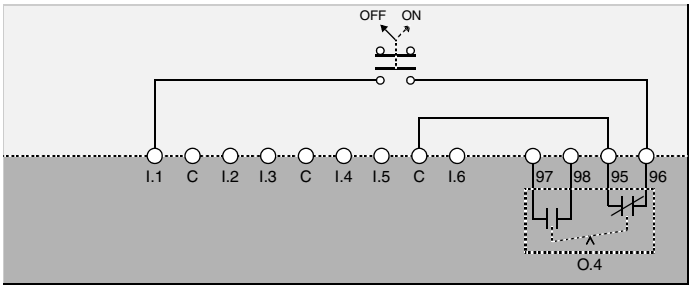
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



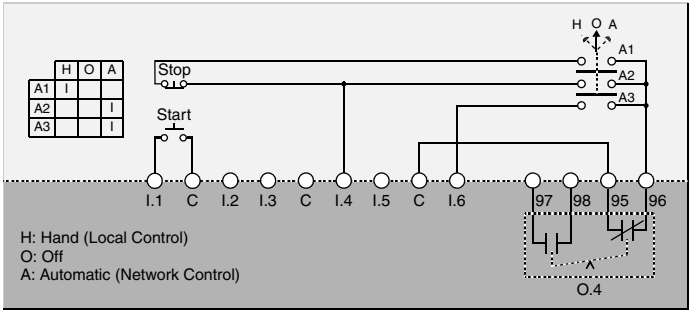
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



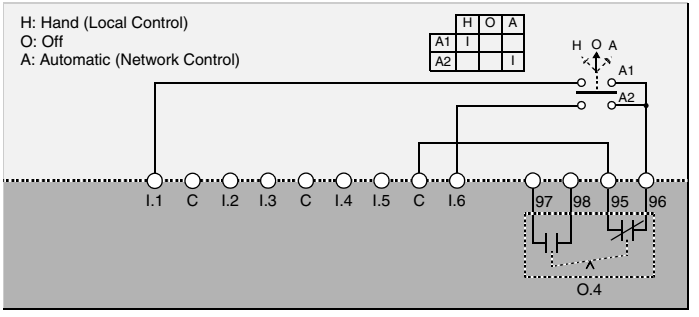
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

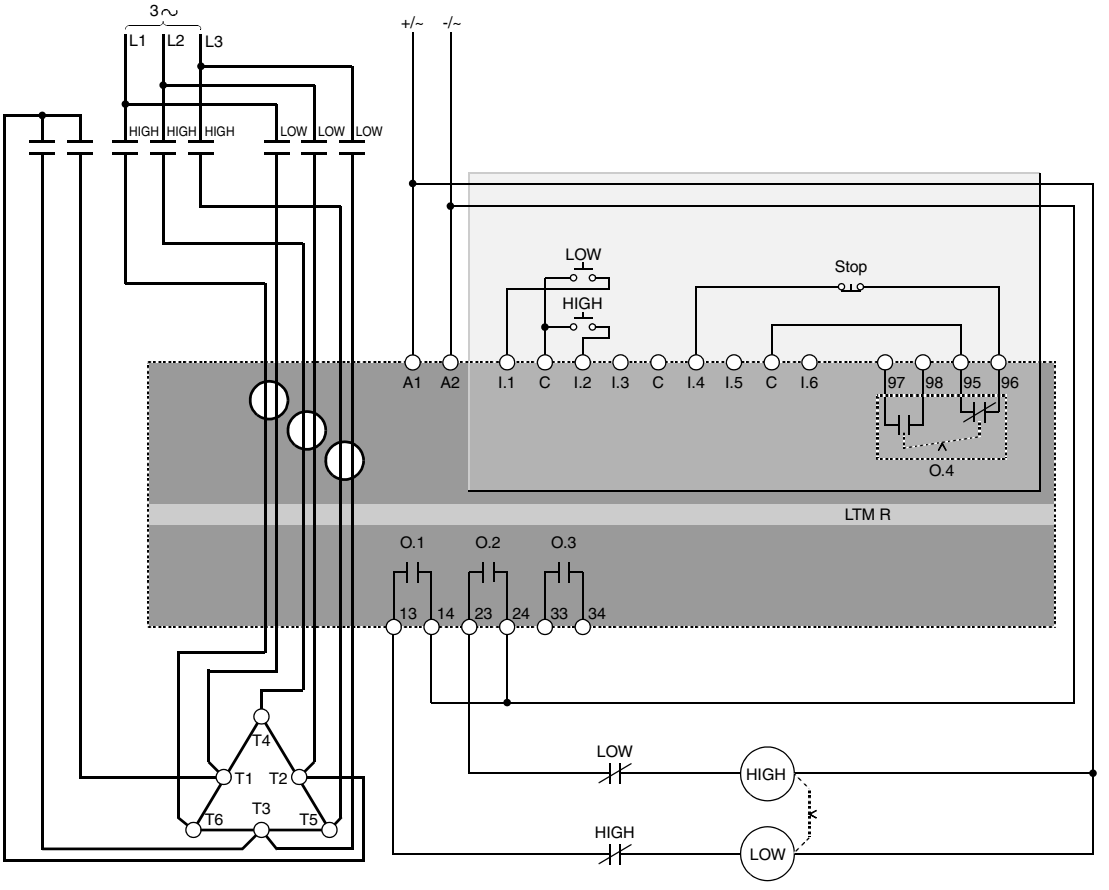
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Speed Mode Wiring Diagrams: Single Winding (Consequent Pole)

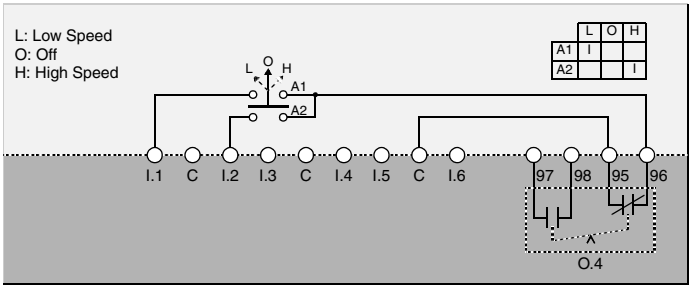
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



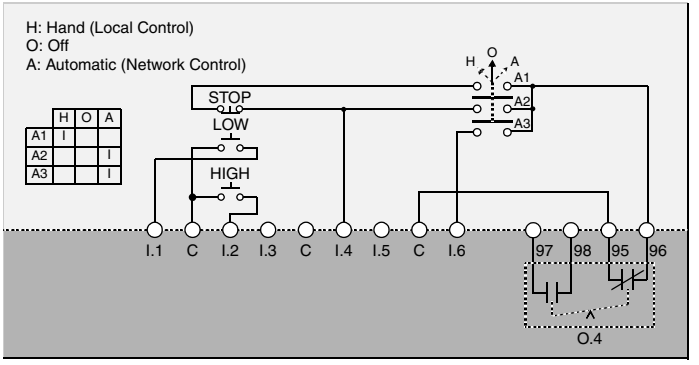
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



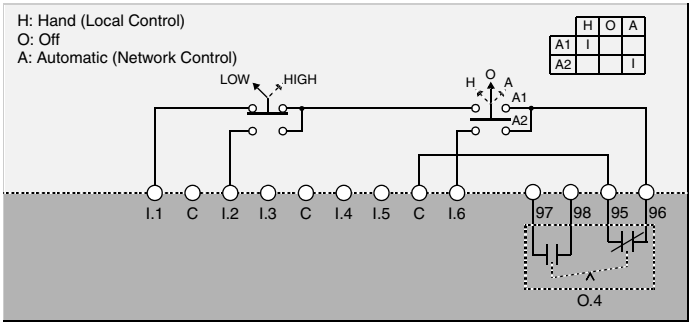
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:



Application Diagram with 2-Wire (Maintained) Local Control with Network Control Selectable

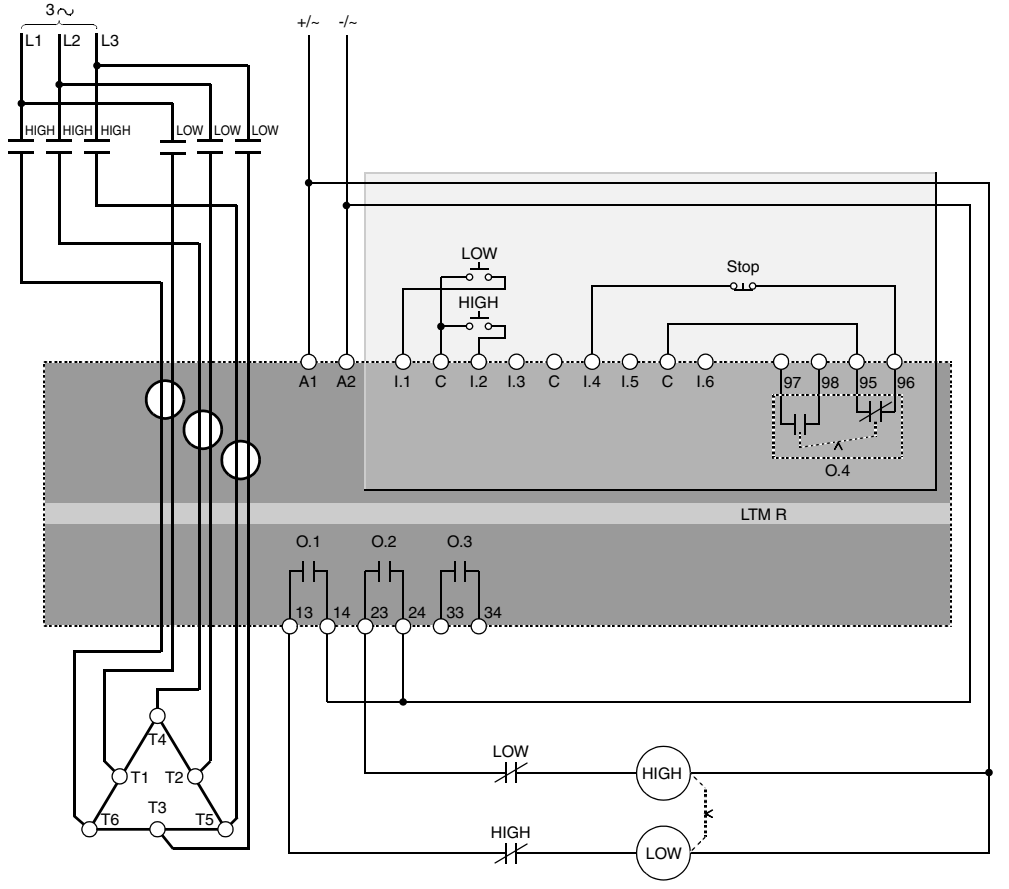
The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Two-Speed Mode Wiring Diagrams: Separate Winding

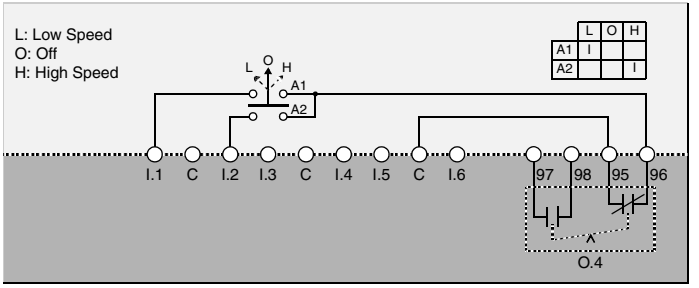
Application Diagram with 3-Wire (Impulse) Local Control

The following application diagram features a 3-wire (impulse) local control wiring diagram:



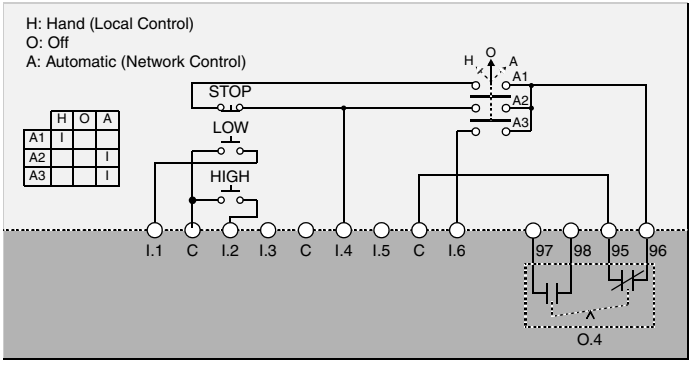
Application Diagram with 2-Wire (Maintained) Local Control

The following application diagram features a 2-wire (maintained) local control wiring diagram:



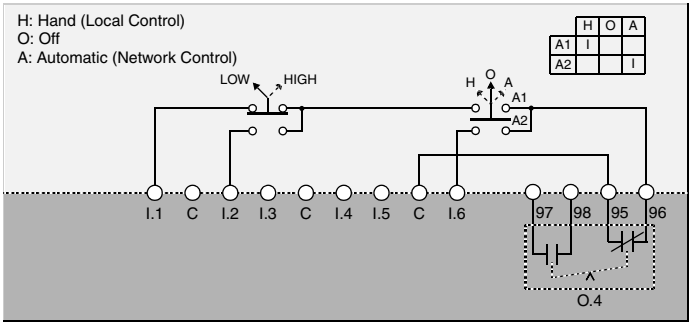
Application Diagram with 3-Wire (Impulse) Local Control with Network Control Selectable

The following application diagram features a 3-wire (impulse) local control with network control selectable wiring diagram:

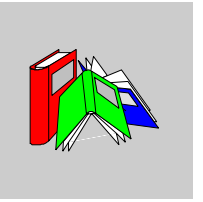


Application Diagram with 2-Wire (Maintained) Local control with Network Control Selectable

The following application diagram features a 2-wire (maintained) local control with network control selectable wiring diagram:



Glossary



A

active power Also known as *real power*, active power is the rate of producing, transferring or using electrical energy. It is measured in watts (W) and often expressed in kilowatts (kW) or megawatts (MW). For single-phase motors its calculation is:

$$\text{Active Power} = (\text{Apparent Power}) \times (\text{Power Factor})$$

For 3-phase motors its calculation is:

$$\text{Active Power} = (\text{Avg. RMS Voltage}) \times (\text{Avg. RMS Current}) \times \sqrt{3} \times (\text{Power Factor})$$

analog Describes inputs (e.g. temperature) or outputs (e.g. motor speed) that can be set to a range of values. Contrast with discrete.

apparent power The product of current and voltage, apparent power consists of both active power and reactive power. It is measured in volt-amperes and often expressed in kilovolt-amperes (kVA) or megavolt-amperes (MVA). Its calculation is:

$$\text{Apparent Power} = (\text{Avg. RMS Current}) \times (\text{Avg. RMS Voltage})$$

C

CANopen An open industry standard protocol used on the internal communication bus. The protocol allows the connection of any standard CANopen device to the island bus.

CT *current transformer.*

D

definite time A variety of TCC or TVC where the initial magnitude of the trip time delay remains a constant, and does not vary in response to changes in the value of the measured quantity (e.g. current). Contrast with inverse thermal.

device In the broadest terms, any electronic unit that can be added to a network. More specifically, a programmable electronic unit (e.g. PLC, numeric controller or robot) or I/O card.

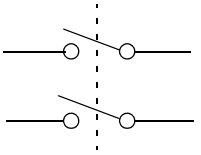
DeviceNet™ DeviceNet™ is a low-level, connection-based network protocol that is based on CAN, a serial bus system without a defined application layer. DeviceNet, therefore, defines a layer for the industrial application of CAN.

DIN *Deutsches Institut für Normung.* The European organization that organizes the creation and maintenance of dimensional and engineering standards.

DIN rail A steel mounting rail, made pursuant to DIN standards (typically 35 mm wide), that allows for easier "snap-on" mounting of IEC electrical devices, including the LTM R controller and the expansion module. Contrast with screw mounting of devices to a control panel by drilling and tapping holes.

discrete Describes inputs (e.g. switches) or outputs (e.g. coils) that can be only *On* or *Off*. Contrast with analog.

DPST *double-pole/single-throw.* A switch that connects or disconnects two circuit conductors in a single branch circuit. A DPST switch has 4 terminals, and is the equivalent of two single-pole/single-throw switches controlled by a single mechanism, as depicted below:



F

FLA *full load amperes.* Same as full load current (FLC).

FLC *full load current.* Also known as *rated current*. The current the motor will draw at the rated voltage and rated load. The LTM R controller has two FLC settings: FLC1 (Motor Full Load Current Ratio) and FLC2 (Motor High Speed Full Load Current Ratio), each set as a percentage of FLC max.

FLC1 *Motor Full Load Current Ratio.* FLC parameter setting for low or single speed motors. Setting range: 5...100% of FLC max. Default setting: 25% of FLC max.

FLC2 *Motor High Speed Full Load Current Ratio.* FLC parameter setting for high-speed motors. Setting range: 5...100% of FLC max. Default setting: 25% of FLC max.

FLCmax *Full Load Current Max.* Peak current parameter. Setting ranges from 1...8400 A in increments of 0.1 A.

FLCmin *Minimum Full Load Current.* The smallest amount of motor current the LTM R controller will support. This value is determined by the LTM R controller model, as follows:

LTM R controller model	FLCmin
LTMR08	0.40 A
LTMR27	1.35 A
LTMR100	5.00 A

H

hysteresis A value—added to lower limit threshold settings or subtracted from upper limit threshold settings—that retards the response of the LTM R controller before it stops measuring the duration of faults and warnings.

I

inverse thermal A variety of TCC where the initial magnitude of the trip time delay is generated by a thermal model of the motor and varies in response to changes in the value of the measured quantity (e.g. current). Contrast with definite time.

M

Modbus® Modbus® is the name of the master-slave/client-server serial communications protocol developed by Modicon (now Schneider Automation, Inc.) in 1979, which has since become a standard network protocol for industrial automation.

N

nominal power *Motor Nominal Power.* Parameter for the power a motor will produce at rated voltage and rated current. Setting range: 0.1...999.9 kW, in increments of 0.1 kW. Default setting: 7.5 kW.

nominal voltage *Motor Nominal Voltage.* Parameter for rated voltage. Setting range: 200...690 V. Default setting: 480 V.

NTC *negative temperature coefficient.* Characteristic of a thermistor—a thermally sensitive resistor—whose resistance increases as its temperature falls, and whose resistance decreases as its temperature rises.

NTC analog Type of RTD.

P

PLC *programmable logic controller.*

power factor Also called *cosine phi* (or φ), power factor represents the absolute value of the ratio of active power to apparent power in AC power systems, as follows:

$$\text{Power Factor} = \frac{\text{Active Power}}{\text{Apparent Power}}$$

Profibus An open bus system that uses an electrical network based on a shielded 2-wire line or an optical network based on a fiber-optic cable.

PTC *positive temperature coefficient.* Characteristic of a thermistor—a thermally sensitive resistor—whose resistance increases as its temperature rises, and whose resistance decreases as its temperature falls.

PTC analog Type of RTD.

PTC binary Type of RTD.

R

reset time Time between a sudden change in the monitored quantity (e.g. current) and the switching of the output relay.

rms *root mean square.* A method of calculating average AC current and average AC voltage. Because AC current and AC voltage are bi-directional, the arithmetic average of AC current or voltage always equals 0. The calculations for rms current and rms voltage are:

$$\text{Irms} = \frac{\text{Imax}}{\sqrt{2}} \qquad \text{Vrms} = \frac{\text{Vmax}}{\sqrt{2}}$$

RTD — *resistance temperature detector.* A thermistor (thermal resistor sensor) used to measure the temperature of the motor. Required by the LTM R controller's Motor Temp Sensor motor protection function.

T

TCC — *trip curve characteristic.* The type of delay used to trip the flow of current in response to a fault condition. As implemented in the LTM R controller, all motor protection function trip time delays are definite time, except for the Thermal Overload function, which also offers inverse thermal trip time delays.

TVC — *trip voltage characteristic.* The type of delay used to trip the flow of voltage in response to a fault condition. As implemented by the LTM R controller and the expansion module, all TVCs are definite time.

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